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NARRATIVE END ITEM REPORT
SATURN S-IVB-504N
VOLUME I, SSC

JULY 1967
DOUGLAS REPORT DAC-56561

FACILITY FORM 602

N70-75404 (ACCESSION NUMBER)
335 (PAGES)
CR-112490 (NASA CR OR TMX OR AD NUMBER)
(THRU)
none (CODE)
(CATEGORY)

SEP 1970
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DOUGLAS
MISSILE & SPACE SYSTEMS DIVISION

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VOLUME I, SSC

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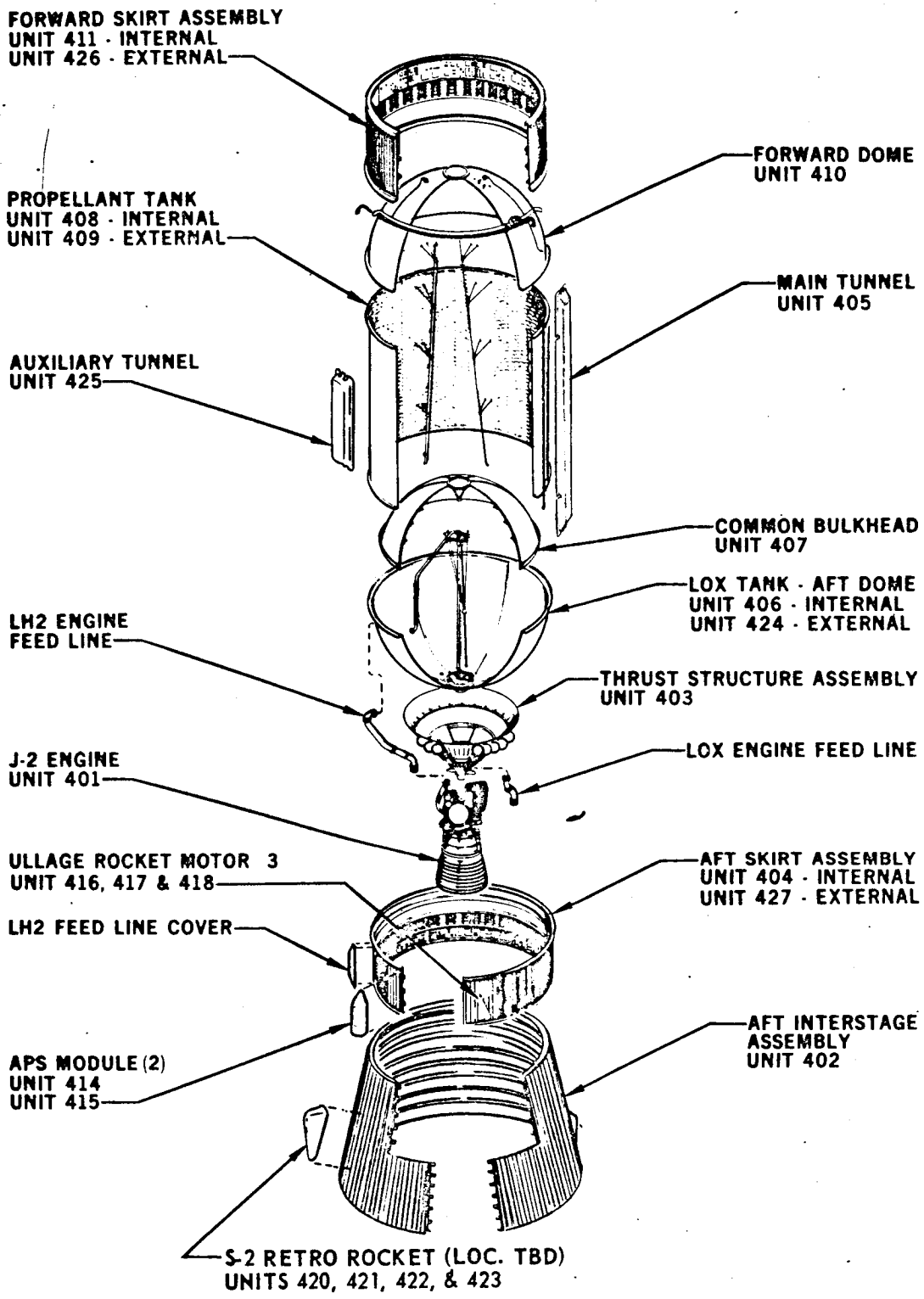
PREPARED FOR:
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
UNDER NASA CONTRACT NAS7-101

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Exploded View of S-IVB Stage for Saturn V

ABSTRACT

The Narrative End Item Report contained herein is a narrative summary of the Douglas manufacturing and Space Systems Center test records relative to the Saturn S-IVB-AS504N Flight Stage (Douglas P/N 1A39300-507, S/N 1009).

Narrations are included on those conditions related to permanent nonconformances which were generated during the manufacturing cycle and existed at the time of Space Systems Center acceptance testing. The report sets forth data pertinent to total time or cycle accumulation on time or cycle significant items. Data relative to variations in flight critical components is also included. There is no provision to update or revise this volume of the NEIR after initial release.

Descriptors

NEIR
Documentation
Configuration
Significant Items
Stage Checkout
Manufacturing and Test

PREFACE

This Narrative End Item Report is prepared by the Reliability Assurance Operations Department of Douglas Aircraft Company, Inc., for the National Aeronautics and Space Administration under contract NAS7-101. This report is presented in response to requirements of NPC 200-2, paragraph 14.2.4, and is issued in accordance with MSFC-DRL-021, Contract Data Requirements, which details the contract data required from Douglas Aircraft Company, Inc. The report summarizes the period of initial stage acceptance testing at the Douglas Space Systems Center, Huntington Beach, California, and transfer to Douglas Sacramento Test Center (STC), Sacramento, California.

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SECTION 1

INTRODUCTION

1.0 INTRODUCTION

1.1 Scope

The NEIR compiles quality evidence and assessments of a particular end item for use in evaluating program objectives and end item usage. This report narrates upon the Saturn S-IVB-504N and discusses the following:

a. Configuration at transfer to Sacramento Test Center.

b. Replacements made during Space Systems Center test and acceptance checkout, including serial number and change letter of articles removed or substituted.

c. Nature of problems and malfunctions encountered.

d. Corrective action taken or pending.

e. Extent of retests or tests not completed.

f. Total operating hours or cycles for each time or cycle significant system or subsystem.

1.2 Format

This document is organized into sections, with each section fulfilling a specific purpose. The title of each section, and a brief outline of its purpose follow.

SECTION

1. INTRODUCTION. This section discusses the scope of the NEIR, the Stage Design Concept, Documentation, and Transfer Data.

2. NARRATIVE SUMMARY AND ALERT FACTORS. A brief summary of principal test areas is presented to give management personnel a concise view of successful test achievement, and remaining areas of concern.

3. STAGE CONFIGURATION. Conformance to engineering design, and data on time/cycle significant items.

4. DETAILED NARRATIVE. A presentation in depth of checkout operations, presented in the chronological order of testing. Failure and Rejections Reports (FARR's) are referenced as applicable for each paragraph.

1.2 (Continued)

APPENDICES

1. TESTING SEQUENCE. Graphic presentation of the order and activity dates of the VCL checkout procedures.

2. CHARTS. Weld defect charts which show weld discrepancies included in Table I Failure and Rejection Reports.

3. TABLES.

   a. TABLE I. A compilation of FARR's against structural assemblies.

   b. TABLE II. A compilation of FARR's recorded during system installations and checkout.

4. FLIGHT CRITICAL ITEMS INSTALLED AT TRANSFER. A listing of those flight critical items installed on the stage at the time of transfer to the Sacramento Test Center.

5. RETESTING REQUIREMENTS. A tabulation of retests required due to modifications or rework subsequent to VCL test completion.

6. GLOSSARY OF TERMS. A list of terms, abbreviations, and phrases used in the NEIR test, with a brief definition.

1.3 Stage Functional Description

A detailed system analysis is beyond the scope of this report. The S-IVB-V Stage End Item Test Plan, 1B66684-503, contains a description of each operational system, and includes a listing of test procedures, with the objective and prerequisites of each test. Stage 504N is primarily a booster stage, consisting of propellant tanks, feed lines, electrical and pneumatic power for operation of stage systems, and such systems as are required for checkout purposes, fuel loading and unloading control, in-flight control and pressurization, and data measurement during these operations.

1.4 Documentation

1.4.1 Data

Manufacturing and test records for this stage include Fabrication Orders (FO's), Assembly Outlines (AO's), Failure and Rejection Reports (FARR's), Serial Engineering Orders (SEO's), Radiographic Inspection Records, Hydrostatic test data, Vehicle Checkout Laboratory (VCL) test data, and vendor data. FO's and AO's record in sequence all manufacturing processes, and Quality Control inspection activities. Any discrepancies from a drawing requirement is recorded on a FARR by Inspection and Test personnel. The FARR is also used to record the Material Review Board (MRB) disposition applicable to the discrepancy. SEO's may be written to define the rework required by a FARR; to change the effectivity of a drawing; or to change other drawing requirements. Radiographic Inspection Records and X-ray photographs of all weld seams are maintained on file by the contractor. All original data is retained in the contractor's Reliability Assurance Department Central Data Files. Vendor technical data is received on functional purchased parts and also retained in Central Data Files. The majority of documentation referenced within this report is included in the log book which accompanies each stage.

1.4.2 Age Requirements

Certain components of the Stage 504N systems have age requirement factors. The particular components are specified in the Age Control Items Master List, DSV-4B-IB/V Flight Stages and Ground Support Equipment, 1B66667. Data defining the age requirements, as well as records relative to age items, replacement schedules, and storage procedures, are on file at SSC. Copies of the age item installation records are also included in the stage log book.

1.4.3 Transfer

Transfer of the Saturn DSV-4B-1-1 (S-IVB-504N) stage, for transport to Douglas Sacramento Test Center, was made on 14 June 1967 at Douglas Space Systems Center, Huntington Beach. Conditional acceptance was made by the Air Force Plant Representative, Quality Assurance Division Representative. A letter, A3-131-12.30.8-L-1143, dated 13 June 1967, from the Douglas Contracts Manager to the NASA/MSFC Resident Management Office, I-CO-SD/DAC, covered the submittal of documentation for purposes of technical transfer of the stage to STC. A copy of that letter and accompanying documentation is included in the stage log book (reference Volume I, Part I, Section I). Stage shipment was accomplished by packing sheet SMX6945-7, dated 15 June 1967.

SECTION 2

NARRATIVE SUMMARY AND ALERT FACTORS

2.0 NARRATIVE SUMMARY AND ALERT FACTORS

The following paragraphs present a narrative summary of manufacturing and stage checkout of the S-IVB-504N stage. Stage manufacturing tests and stage checkouts conducted at the Space Systems Center (SSC) are summarized in paragraphs 2.1 and 2.2 respectively. The post-checkout Propellant Tanks Leak Check is summarized in paragraph 2.3, and the Final Inspection, Weight and Balance, and Preshipment Preparations are summarized in paragraphs 2.4, 2.5, and 2.6 respectively. Detailed narrations on these tests and operations are presented in section 4.

Paragraph 2.7 summarizes any tests that were not completed prior to stage transfer, and any retesting that will be required. Paragraph 2.8 summarizes the incomplete failure and rejection reports that were transferred open at the time of stage transfer from SSC to STC.

2.1 Stage Manufacturing Tests

Two major manufacturing tests were conducted on Stage 504N during the manufacturing sequence, to verify the structural integrity of the stage propellant tank assembly. A hydrostatic proof test was successfully accomplished between 13 and 15 October 1966, verifying that the tank assembly could withstand the required test pressures without damage or major leakage. Two minor leaks encountered during this test were corrected to a satisfactory condition. A propellant tanks leak check, accomplished on 20 and 21 October 1966, verified that no leaks existed in the tank assembly welds, or in areas where the tank wall was penetrated by fasteners used to attach structural items to the tank assembly. At the conclusion of these tests, the stage tank assembly was accepted for continued manufacturing, and systems installation. A more detailed narration on these tests is presented in paragraph 4.1.

2.2 Stage Checkout, SSC

The stage was installed in SSC VCL checkout tower 5 on 8 February 1967. Checkout of the stage systems started on 27 February 1967, and was completed on 12 April 1967, after 33 working days of activity. A total of 34 checkout procedures involving the stage systems were accomplished during this period. The stage was removed from the VCL on 13 April 1967. Detailed narrations on the checkout procedures are presented in paragraph 4.2, in the order in which the tests were started. Appendix I shows the chronological sequence of the tests, giving the detailed narration paragraph number, the H&CO drawing number and test title, and the dates each test was active.

Prior to turning on the stage power, checks were made of the stage wiring, the forward skirt thermo-conditioning system, the cryogenic temperature sensors, the antenna systems, the umbilical interface wiring, and the engine alignment. No major problems were encountered during this period, although some FARR's and procedure revisions were written to correct minor problems. The decoder assembly 404A62A214, P/N 1A74053-503, was replaced during the stage wiring checks, and the engine control and bus switching module, P/N 1A74890-501, was replaced during the umbilical interface check.

Power was first applied to the stage on 6 March 1967 with the initiation of the stage power setup and turnoff procedures. There were no major problems, although several procedure revisions were required to correct minor problems.

Following the application of stage power, testing of the signal conditioning equipment and propellant level sensors was accomplished with no major problems. One 20 volt excitation module, P/N 1A74036-1.1 was replaced during the signal conditioning equipment test. The DDAS calibration procedure was

2.2 (Continued)

accomplished with some procedure revisions and three FARR's. The PCM/DDAS assembly 411A97A200, P/N 1A74049-511, and the CP1-B0 multiplexer 404A61A200, P/N 1B62513-529, were both replaced. The aft skirt thermo-conditioning system was checked with no problems, although some procedure revisions were required. The propulsion system control console/stage compatibility test was accomplished with no problems.

Leak checks of the propulsion components, the LH_2 tank pressurization system, the cold helium system, the pneumatic control system, the J-2 engine, the propellant tanks system, and the repressurization system were conducted during March, concurrently with the electrical systems tests. A number of leaks were found and corrected, numerous procedure revisions were made, and several FARR's were written. A check valve and several pipe assemblies were replaced, and, during the propellant tanks check, the LH_2 fill and drain valve, P/N 1A48240-505, was replaced.

The electrical system tests were accomplished with no major problems, although numerous revisions and FARR's were written to correct minor problems. During the power distribution system test, range safety decoder 411A99A1, P/N 50M10698, was replaced. Problems during the DDAS automatic test required the replacement of several transducers and the CP1-B0 multiplexer 404A61A200, P/N 1B62513-529. The propellant utilization calibration procedure and automatic procedure, the EBW system test, the APS test, and the range safety receiver and system tests, were all accomplished satisfactorily.

The propulsion system automatic test was accomplished with only minor problems, which were corrected by procedure revisions. The hydraulic system

2.2 (Continued)

fill, flush, and bleed procedure was completed after minor leaks were corrected. The hydraulic system automatic test was also accomplished with no major problems, although several revisions were required.

The individual system tests were completed by early April, and the all systems test was initiated on 7 and 8 April 1967. No major problems were encountered during this test, but minor problems required numerous revisions and several FARR's. The PCM RF assembly 411A64A200, P/N 1B52721-509, and the reflected power detector 411MT744, P/N 1A74776-501, were replaced during the test. In addition, the engine pump purge module, P/N 1A58347-505, and pressure switch 403S2, P/N 1B52623-515, were replaced and satisfactorily checked out after the test was completed. The final thermo-conditioning system securing procedure was accomplished on 12 April 1967, with no particular problems.

2.3 Post-Checkout Propellant Tanks Leak Check

Following the VCL final acceptance checkout, the stage was moved to tower 8 for a production acceptance leak test of the propellant tanks assembly. This was accomplished on 17 and 18 April 1967.

The leak check was performed by pressurizing the tanks with gaseous helium, and utilizing the USON leak detector and bubble solution to determine areas of structural deficiency. Several noted leakage conditions were reworked, and the procedure was rerun acceptably on 18 April 1967.

A detailed narration of this test appears in paragraph 4.3.

2.4 Final Inspection

Following final manufacturing operations and modification, the final inspection of Stage 504N was performed between 22 and 25 May 1967, to locate and correct any remaining stage discrepancies. A total of one hundred twenty-one mechanical and electrical area discrepancies were recorded during the inspection, mostly of a minor nature. All except three of these discrepancies were cleared to an acceptable condition without requiring failure and rejection report action. The remaining three problems were noted on FARR's A257902, A261104, and A261105, and were acceptably corrected. A more detailed narration on the final inspection is presented in paragraph 4.4.

2.5 Weight and Balance

Following the final inspection, the stage was rotated to a horizontal position, and prepared for the weight and balance operation. On 9 June 1967 the stage was weighed by means of a three point electronic weighing system. Three electronic load cells, one aft and two forward, measured the reaction forces of the otherwise unsupported stage. The reaction force measurements were then used to determine that the stage shipping and handling weight was 26,335.4 pounds, the stage weight corrected for Standard Gravity in a vacuum was 26,397.8 pounds, and the stage longitudinal center of gravity was located at station 328.12. The stage was then loaded onto its transporter for final pre-shipment preparations. Paragraph 4.5 presents a more detailed narration on these operations.

2.6 Preshipment Purge

The final operation before the stage was shipped to STC was the preshipment purge. Gaseous nitrogen was used to purge the stage systems to dewpoints of -37°F for the LH_2 system, and -38°F for the LOX system. The necessary desiccants were installed to maintain the proper stage environment during the air transport operations. Paragraph 4.6 presents a more detailed narration on this operation.

2.7 Incomplete Tests and Retesting Requirements

There were no incomplete H&CO's, as all VCL test procedures were activated and completed.

LOX vent and relief valve, P/N 1A49590-515, S/N 545, and LH_2 continuous vent module, P/N 1B67193-501-005, S/N 04, were not tested during VCL operations. Interim use items, P/N's 1A49590-513-018, and 1B51753-501-007, respectively, were installed for testing purposes. The interim use items were removed on 22 May 1967, after testing had been completed and the flight parts were installed. Manufacturing tests were performed on the flight use items at the time of installation, but no systems tests were attempted. The parts will be checked out in the system during STC prefiring operations.

Three Rocketdyne engine transducers were not installed during VCL operations. These were for the LH_2 turbine inlet temperature, measurement C1; the LOX turbine inlet temperature, measurement C2; and the LOX turbine outlet temperature, measurement C215. Interim use transducers, P/N NA5-27323T3, were installed for use during VCL testing, and were removed prior to stage shipment. Flight use transducers are to be installed at STC prior to static acceptance firing. Finally, nine actuator control modules, P/N's 1B66692-1 and -501,

2.7 (Continued)

were replaced for checkout purposes by IUM P/N 1B65292-501. Flight use parts will be installed at STC and tested prior to static firing.

Auxiliary hydraulic pump, P/N 1A66241-511, S/N X454590, was not installed on the stage during sytems checkouts. Pump, S/N X454664, which was on the stage, was removed on 16 May 1967. The new pump will require checkout during prefiring tests at Sacramento. In addition, testing of the Model DSV-4B-1-A1 dual repressurization unit and the O_2H_2 burner (as modified for the dual repressurization system), will be completed at STC.

Retesting required by modification or rework subsequent to VCL test completion is tabulated in Appendix V.

2.8 Incomplete FARR's

Only one FARR was not closed at the time Stage 504N was transferred to STC. FARR A257907, dated 12 June 1967, reported on a short circuit which was discovered during the course of the GN_2 purge, H&CO 1B65783. A switch was thrown on the GSE, which should have activated the LH_2 vent switch on the stage. However, when the switch was closed, a fuse blew. It was not ascertained at the time of transfer whether the short existed in the GSE or the stage wiring. A continuity check was performed between wire harness 411W6P2 and 411A99A10J8. The results of this test were pending at the time of transfer.

SECTION 3

STAGE CONFIGURATION

3.0 STAGE CONFIGURATION

The paragraphs of this section define the configuration of the Saturn S-IVB-504N Stage, and note the variations applicable thereto. Paragraph 3.1 discusses the means used to verify the stage configuration; paragraph 3.2 describes those flight critical items which deviate from the stage design; and paragraph 3.3 contains those variations in stage configuration which represent changes in the scope of the program.

A listing, in tabular form, of all time/cycle significant items on the stage, along with the accumulated time/cycles for each item, is included in this paragraph.

Existing contractural configuration control papers are referenced wherever possible.

3.1 Design Intent Verification

This configuration of the stage is defined in the Engineering Configuration List (ECL), Space Vehicle, Model DSV-4B-1-1, Manufacturing Serial Number 1009, revision A, dated 1 May 1967. This ECL document includes a listing of all parts, non-hardware drawings, and manufacturing and process specifications required for the manufacture and test of the stage, as defined by Engineering production drawings and EO releases. The ECL has been transmitted to NASA under a separate cover.

Verification of design intent was accomplished by comparing the ECL with the Planning Configuration List (PCL), and the Reliability Assurance Department As-Built Configuration List (ABCL). Any discrepancies found were resolved by the contractor, and a listing of the resultant action is filed at the contractor's facility.

3.2 Stage Variations - Flight Critical Items

Identification of components and assemblies which are variations to the stage design is accomplished by including the serial engineering order (SEO) dash number after the part number. Those flight critical items which are installed in the stage with SEO variations are reviewed in this paragraph. A description of the variation, along with part number and serial number, is presented for each part.

3.2.1 Oxidizer Mass Probe (1A48430-509-010D, S/N C1)

SEO 1A48430-509-010D authorized the removal and disassembly of the LOX mass probe, in order to determine the ability of each coaxial center socket contact to retain a 1/2 oz., 0.0280, -0.0000, +0.0002, inch diameter test pin. All sockets which were unable to retain the weighted test pin were removed and replaced, and the probe was then reinstalled in the stage with a new conoseal and "O" ring. This was necessary because preliminary qualification testing had indicated that the separation force of the coaxial center contacts was inadequate (reference Douglas memo A3-860-KDCA-M-651).

3.2.2 Oxidizer Tank Relief Valve (1A49590-513-018, S/N 530)

SEO 1A49590-513-018 provided for the acceptance of out-of-tolerance cracking and reseat pressures for the valve, as the part was an interim use item for checkout only, and will be replaced prior to static firing. The out-of-tolerance values did not affect the checkout procedures.

3.2.3 Fuel Vent Directional Control Valve (1A49988-1-002, S/N 0022)

SEO 1A49988-1-002 provided that this valve be installed on Stage 504N as an interim use item for checkout purposes only, despite a high internal leakage rate. This was a salvage disposition of FARR A241902, which rejected the valve at STC and removed it from Stage 208. The valve was removed from Stage 504N by FARR A248634, and rejected for the original seal damage. Directional control valve, P/N 1A49988-1, S/N 23, was installed on 20 March 1967 for the remainder of the VCL checkout operations.

3.2.4 Helium Fill Module (1A57350-507-002C, S/N 0227)

SEO 1A57350-507-002C authorized the removal of the relief valve from the helium fill module. An on-board relief valve was no longer required, and its deletion from the module resulted in an improvement in reliability.

3.2.5 Hydraulic Actuator Assembly (1A66248-505-011A, S/N's 52 and 63)

SEO 1A66248-505-011A authorized that the hydraulic actuator assemblies be cleaned per MSFC-SPEC-237A, primed per MIL-P-23377, and top coated per MIL-C-22750A. This was done because the aluminum parts on the actuators might have been subject to stress corrosion.

3.3 Scope Change (SC)/Engineering Change Proposal (ECP) Verification

Scope changes/Engineering change proposals, along with applicable verification data, are listed in the form DD829-1 which is included in the Stage Log Book. The following paragraphs list those SC/ECP's which were incorporated and verified prior to transfer of the stage to STC. Paragraph 3.3.1 contains the numbers of those SC/ECP's which were incorporated in the initial design of Stage 504N. Paragraph 3.3.2 lists and briefly describes those SC/ECP's which were incorporated and verified subsequent to the release of initial

3.3 (Continued)

stage drawings, but prior to transfer to STC. Those SC/ECP's which are pending verification, and which will be verified at STC or subsequent to stage turnover to NASA, will be described in Volume II.

3.3.1 Scope Changes/Engineering Change Proposals Incorporated in the Initial Design

SC 1016B	SC 1232A
SC 1024	SC 1266
SC 1027B	SC 1276
SC 1075B	SC 1277
SC 1096	SC 1278A
SC 1104A	SC 1282
SC 1115	SC 1295
SC 1151	SC 1306
SC 1152	SC 1354
SC 1167	SC 1363
SC 1176	SC 1364
SC 1185	SC 1390
SC 1195A	SC 1397
SC 1211A	ECP X005
SC 1221A	ECP X043

3.3.2 Scope Changes/Engineering Change Proposals Incorporated and Verified Prior to Transfer

The following SC/ECP's were incorporated and verified by Douglas and AFQA personnel prior to transfer of the Stage to STC:

a. ECP 0314, authorized by MSFC letter I-60-SD-L-329-66, provided for rework and installation of the Model II switch selector.

b. ECP 0364, authorized by letter L307, provided for the addition of a check valve to the APS helium supply line.

c. SC 1045B, authorized by CCO 118, provided design specifications for the forward skirt thermo-conditioning system.

d. SC 1124, authorized by CCO 259, provided closed loop checkout ability for the stage range safety command RF system.

e. SC 1153A, authorized by CCO's 163 and 280, provided for the redesign of the propellant utilization system, to enable rapid installation of system components under prelaunch conditions at KSC.

3.3.2 (Continued)

f. SC 1187, authorized by CCO's 136, 172, and 330, installed the MSFC furnished control accelerometers and rate gyro.

g. SC 1189, authorized by CCO's 111 and 126, provided for the design, release, and manufacture of the necessary parts and documents for the two-hour and four-and-one-half hour translunar coasts.

h. SC 1193, authorized by CCO 156, provided for the redesign of the LOX tank vent line and supporting hardware.

i. SC 1203, authorized by CCO 168, provided for RPM measurement of the LOX and LH_2 turbopumps.

j. SC 1205, authorized by CCO 173, provided for the installation of three additional interface connectors.

k. SC 1207, authorized by CCO's 197, 213, 330, 343, and 414, provided for the modification of the propellant utilization system.

l. SC 1218, authorized by CCO's 202 and 330, provided for a recirculation type chilldown system.

m. SC 1219, authorized by CCO 201, provided for the removal of the telemetering circuit monitoring the APS.

n. SC 1241, authorized by CCO 222, provided an additional sensing element for the engine cutoff circuit.

o. SC 1274, authorized by CCO's 264, and 330, provided short circuit protection for the power supplies.

p. SC 1297A, authorized by CCO's 284 and 330, provided that the forward skirt venting system be modified.

q. SC 1304, authorized by CCO 288, provided for the reduction of LH_2 tank pressure, with associated design changes.

r. SC 1312, authorized by TD64-101 and CCO 47, provided for reduced tolerance on dome segments.

s. SC 1326, authorized by CCO's 279 and 595, provided stage and GSE pressure measurements for the recirculation chilldown pumps.

t. SC 1376A, authorized by CCO's 395 and 467, provided for the reduction of trapped propellants at burnout.

u. ECP X021, authorized by CCO 363, provided for static test monitoring of the engine turbopump RPM.

3.3.2 (Continued)

v. ECP X056, authorized by CCO's 413 and 572, provided that consecutive reference designation numbers be assigned to stage relays.

w. ECP X082, authorized by CCO's 434 and 539, provided new engine transducer design requirements.

x. ECP X085, authorized by CCO 444, provided for the redesign of the engine cutoff circuitry.

y. ECP X092, authorized by CCO's 451 and 539, provided for additional MSFC flight control wiring.

z. ECP X099, authorized by CCO 461, provided for additional hardwire measurements through the umbilical.

aa. ECP X113, authorized by CCO's 472 and 539, provided a method for implementing the secure range safety command system.

ab. ECP X119, authorized by CCO's 502 and 586, provided a revised venting system for the LH_2 tank.

ac. ECP X124, authorized by CCO's 506, 539, and 562, provided for changes in the stage for Rocketdyne ECP compatibility.

ad. ECP X136, authorized by CCO's 329, 538, and 631, provided for the release of a coolant system common to both the S-IB and S-V stages.

ae. ECP X137, authorized by MSFC letter I-V-S-TD-65-53, defined the programmed mixture ratio.

af. ECP X147, authorized by letter D151, provided for the addition of a relay to the aft 28 vdc power distribution assembly.

ag. ECP X176, authorized by CCO 587, modified the thrust structure.

ah. ECP X178, authorized by CCO 597, provided for the release of a stage positive pressure system.

ai. ECP X198, authorized by CCO's 658 and 692, revised the engine thrust OK circuits.

aj. ECP X199, authorized by CCO 63C, provided redesign criteria for the APS modules.

ak. ECP X209, authorized by CCO 847 and NASA letter L96, revised forward skirt paint requirements.

al. ECP X217, authorized by CCO 698, provided black teflon hoses for the hydraulic system.

3.3.2 (Continued)

am. ECP X221, authorized by CCO 693, provided for the redesign of the APS gemini engine nozzle supports.

an. ECP X239, authorized by CCO 729, provided for implementation of the safing engine start circuits.

3.4 Time/Cycle Significant Items

Twenty-seven items installed on Stage 504N are time/cycle significant as defined by Design Requirements Drawings 1B55423, 'Government Furnished Property Time/Cycle Significant Items, and 1B55425, Reliability Time/Cycle Significant Items. The following table lists these items, along with the time/cycles accrued on each part, and the maximum allowable limits prescribed by Engineering.

TABULATION OF TIME/CYCLE SIGNIFICANT ITEMS

PART NUMBER AND PART NAME	SERIAL NUMBER	ENGINEERING LIMITS	ACCUMULATED MEASUREMENT	REMARKS
G.F.P. Items (1B55423 E)				
40M39515-119 EBW Firing Unit	463	1,000 firings	18 firings	
	464	1,000 firings	18 firings	
40M39515-113 EBW Firing Unit	238	1,000 firings	21 firings	
	239	1,000 firings	28 firings	
	240	1,000 firings	20 firings	
	245	1,000 firings	15 firings	
50M10697 Command Receiver	104	2,000 hours	15.8 hours	
	167	2,000 hours	16.6 hours	
50M10698 Decoder, Range Safety	92	2,000 hours	23.7 hours	
	133	2,000 hours	20.7 hours	

TABULATION OF TIME/CYCLE SIGNIFICANT ITEMS

PART NUMBER AND PART NAME	SERIAL NUMBER	ENGINEERING LIMITS	ACCUMULATED MEASUREMENT	REMARKS
50M35076-1 Control Relay Package (DAC 1B57731-1)	337	25,000 cycles	M1: 110 cycles M2: 97 cycles M3: 90 cycles	
	349	25,000 cycles	M1: 151 cycles M2: 117 cycles M3: 149 cycles	
50M67864-5 Switch Selector	159	250,000 cycles	55,238 cycles	
103826 J2 Engine (for gimbal cycles)	J2094			This data includes all engine gimbal cycles at SSC, plus cycles brought forward from Rocketdyne records. The cycles data is expressed as a percentage of Design Limits based on a gimbal angle, and can vary from 250 to 10,000 + cycles as noted. * The indicated percentage was computed from the Engine Log Records utilizing the graph per R/NAA Rocket Engine Data Manual R-3825-1, Page 9-36 and 9-37.
a. Customer connect lines and inlet ducts		250-10,000	6.84%*	
b. Gimbal bearing.		250-10,000	6.92%*	
c. Firing Time.		3,750 seconds	355.5 sec.	

TABULATION OF TIME/CYCLE SIGNIFICANT ITEMS

PART NUMBER AND PART NAME	SERIAL NUMBER	ENGINEERING LIMITS	ACCUMULATED MEASUREMENT	REMARKS
Reliability Items (1B55425 M)				
1A48858-1 Sphere, Helium	1063	50 cycles	2 cycles	
	1069	50 cycles	3 cycles	
	1093	50 cycles	2 cycles	
	1112	50 cycles	2 cycles	
	1113	50 cycles	2 cycles	
	1120	50 cycles	2 cycles	
	1125	50 cycles	2 cycles	
	1135	50 cycles	2 cycles	
	1140	50 cycles	2 cycles	
1A49423-507 LOX Chilldown Pump	1763	20 hours	1.57 hours	
1A59562-505 Potentiometer, PU Bridge	1033	5,000 cycles	432 cycles	R1 potentiometer
	1035	5,000 cycles	442 cycles	R2 potentiometer
1A66241-511 Pump, Hydraulic Auxiliary Motor Driven	X454590	120 hours 300 cycles	33.2 hours 51 cycles	

SECTION 4

DETAILED NARRATIVE

4.0 DETAILED NARRATIVE - Stage Checkout

A detailed narration of the stage checkout is presented in this section in the chronological order of testing. The major paragraphs comprising the detailed narrative are: 4.1 Stage Manufacturing Tests; 4.2 Stage Checkout - SSC/VCL; 4.3 Propellant Tanks System Leak Test; 4.4 Final Inspection; 4.5 Weight and Balance; and 4.6 Preshipment Purge. These major paragraphs are subdivided to the degree required to present a complete historical record of stage checkout.

Permanent nonconformances and functional failures affecting the stage have been recorded on FARR's, and are referred to by serial number throughout this section (e.g. FARR A228562). The referenced FARR's are presented in numerical order in Table I and Table II of Appendix III.

4.1 Stage Manufacturing Tests

During the manufacturing sequence of Stage 504N, two major manufacturing tests were conducted to verify the structural integrity of the stage propellant tanks assembly. These two tests, the hydrostatic proof test and the tanks assembly leak test, are presented in this paragraph. FARR's referenced in this paragraph are presented in Table I of Appendix III.

4.1.1 Hydrostatic Proof Test (1B38414 G)

The hydrostatic proof test was conducted on the tank assembly for Stage 504N to ensure the structural integrity of the LOX and LH_2 tanks, and to verify that the tank assembly could withstand the required test pressures without leakage or damage. The item subjected to this test was the tank assembly, P/N 1A39303-521, S/N 1009. The tank assembly was tested without the thrust structure installation, P/N 1A39312, the sump installation, P/N 1A39154, or the door installations, P/N's 1A39273 and 1B64441.

Using acceptance test procedure A659-1B38414-1-PATP12, the hydrostatic proof test was started in the early morning of 13 October 1966, and was completed approximately forty-eight hours later in the early morning of 15 October 1966. The test was conducted by varying the water head pressure inside and outside the LOX and LH_2 tanks as required to accomplish the following:

a. Proof the common bulkhead to a positive (internal) pressure differential of 27.5 +0.5 -0.0 psi, and the LOX tank at the common bulkhead joint to 28.7 +0.5 -0.0 psi.

b. Proof the common bulkhead to a negative (external) pressure differential of -20.6 +0.0 -0.5 psi, and the LH_2 tank at the common bulkhead joint to 22.5 +0.5 -0.0 psi.

c. Proof the aft LOX tank to a positive (internal) pressure differential of 51.0 +0.5 -0.0 psi, and the common bulkhead at the common bulkhead to aft dome joint to 19.2 +0.5 -0.0 psi.

d. Proof the LH_2 tank aft dome to 38.0 +0.5 -0.0 psi, and the common bulkhead at the common bulkhead to aft dome joint to a positive (internal) pressure differential of 5.2 +0.0 -0.5 psi.

Because of the method of performing the test, and the locations where pressures and water levels were measured, the values recorded during the test did not correlate directly with the specified pressure requirements. However, the measured pressures and water levels were the correct values to ensure that the pressure requirements were met. The test pressures and water levels

4.1.1 (Continued)

recorded during the appropriate steps of the procedure were: a LOX tank pressure of 52 psi with a water level of 81.0 feet; a common bulkhead positive pressure of 46 psi with a water level of 61.2 feet; a common bulkhead negative pressure water level of 51.7 feet; and an LH_2 tank pressure of 52 psi with a water level of 87.6 feet. These pressures were maintained for five minutes, thereby verifying that there was no leakage in the tank assembly. Following the test, the tank assembly was drained, rinsed, and dried, in preparation for further manufacturing operations.

No major discrepancies were encountered during this test. Leakages noted at the LOX tank sump and at the LH_2 tank helium bottle cover were satisfactorily corrected without requiring failure and rejection report action. A total of eighteen revisions were made to the procedure for the following:

a. Two revisions deleted preliminary inspection steps requiring verification of the sodium dichromate solution particle count, and verification that the dichromate system filters had been cleaned since the last hydrostatic test.

b. Seven revisions deleted the use of the LH_2 tank 84.5 foot level sensor indicator lamp, F-18.

c. One revision deleted the use of the LOX tank 3.9 foot level sensor indicator lamp, F-1.

d. Two revisions added instructions to depressurize and drain the LOX tank, repair the leak at the LOX tank sump, and refill the LOX tank to continue the test.

e. Four revisions added instructions to drain the LH_2 tank, enter the tank and repair the leak at the bottom helium bottle cover assembly, and refill the tank to continue the test.

f. One revision changed an expected indication for the LOX tank 36.1 foot standpipe valve from CLOSED to OPEN at one point in the test.

g. One revision noted that the R2 strip chart recorder malfunctioned during the test, and was repaired.

4.1.2 Propellant Tanks Leak Check (1B38414 G)

The propellant tanks leak check verified the integrity of the Stage 504N tank assembly, and ensured that no leaks existed in the tank assembly welds, or in areas where the tank wall was penetrated by lockbolts or other fasteners attaching structural items to the tank assembly. The item tested by this procedure was tank assembly, P/N 1A39303-521, S/N 1009.

The leak check was initiated on 20 October 1966, using test procedure A659-1B38414-1-PATP27, and was completed on 21 October 1966. There were no parts shortages at the start of the test, and no parts were changed as a result of the test.

The first part of the test was a preliminary leak check of the production test equipment (PTE) adapters and connectors. The LOX tank was pressurized to 3.5 psig with gaseous nitrogen, and bubble solution was used to check the LOX tank PTE adapters and connectors for leakage. The LH_2 tank was then pressurized to 3.2 psig with gaseous nitrogen, and the LH_2 tank PTE adapters and connectors were similarly checked for leakage. During the latter test, two leaks were noted, one at the LH_2 vent adapter, and one at the propellant utilization leadout wire adapter. These leaks were not great enough to affect the tank assembly testing, and were acceptable. A tank assembly integrity test was then conducted by incrementally pressurizing the LOX and LH_2 tanks with gaseous nitrogen. The final pressures were 12.4 psig for the LOX tank, and 12.2 psig for the LH_2 tank. With the nitrogen supply valves closed, pressure was maintained for ten minutes and then remeasured as 12.4 psig for the LOX tank, and as 12.1 psig for the LH_2 tank. This indicated that there were no tank leakages. The tanks were then vented to atmosphere until the pressure in each tank was 8.3 psig.

4.1.2 (Continued)

The last part of the test was a freon injection check. Freon gas was flowed into the tanks at a 20.0 cubic foot per minute rate until the pressure reached 10.2 psig in both the LOX and LH_2 tanks. The freon system downstream of the evaporator, and from the evaporator to the freon bottles, was then bled to atmosphere. After allowing one hour for freon gas circulation, bubble solution and a halogen detector were used to leak check the tank assembly at all weld areas and at all lockbolts or other structural fasteners that penetrated the tank wall. At the conclusion of the freon leak check, the tanks were exhausted to atmosphere, then purged with dry air and recapped to ensure cleanliness.

No problems or discrepancies were encountered involving the tank assembly.

As noted, the PTE leaks were acceptable, and no failure and rejection report action was required. Six revisions were made to the procedure, as follows:

a. Two revisions changed the PTE adapter callouts for both the LOX and LH_2 chilldown return fittings, ports 3 and 4, from A659-1A57431-PTE4 AD10-10072 to A659-1A57431-PTE1 AD10-10072.

b. One revision changed the PTE adapter callout for the LH_2 chill pump fitting, port 6, from A659-1A57431-PTE1 AD10-10002 to A659-1A57431-PTE1 AD10-10012.

c. One revision added two PTE adapter callouts, both A659-1A57431-PTE1 AD10-10072, for the LOX chill return fitting, port 11, and the LH_2 chill return fitting, port 12.

d. Two revisions deleted the requirement for no allowable leaks during the PTE adapter and connector preliminary check, and noted the leaks at the LH_2 vent PTE and the PU leadout PTE following the 3.2 psig LH_2 tank pressurization.

4.2 Stage Checkout - SSC/VCL

This paragraph details the tests performed on Stage 504N in the Vehicle Checkout Laboratory at the Douglas Space Systems Center, prior to transfer of the stage for shipment to the Sacramento Test Center. Stage 504N was placed in tower 5 of the VCL on 8 February 1967. System checkouts were initiated on 27 February 1967 and continued until 12 April 1967. Checkout was active on thirty-three working days during this period. All tests required by the End Item Test Plan, 1B66684-503B, dated 14 April 1967, were activated and completed.

Twelve interim use parts were installed at the time of the all systems simulated flight test. These were the IUM LOX vent and relief valve, P/N 1A49590-513-018; the IUM LH_2 continuous vent module, P/N 1B51753-501-007; seven IUM actuator control modules, P/N 1B65292-501; and three Rocketdyne transducers, P/N NA5-27323T3. Except for the actuator control modules, these interim use items were removed prior to stage shipment. The flight use items will be installed for STC prefiring testing.

Paragraphs 4.2.1 through 4.2.34 contain information on the individual tests conducted, presented in the order the tests were started.

4.2.1 Continuity Compatibility Check (1B59780 A)

Before the application of any bus power to Stage 504N, an end-to-end continuity check was made of all electrical cables and wire harnesses installed on the stage. This ensured the integrity of the stage electrical systems, and verified that the stage was prepared for the application of electrical power for VCL testing. Where possible, the end-to-end continuity of wire runs was measured through electrical component boxes. The test involved all wire harnesses and electrical wiring installed on the stage.

Initiated on 27 February 1967, the procedure was completed, except for four measurements, by 6 March 1967, after six days of activity. The four remaining measurements were made on 7 and 8 March 1967, and the procedure was accepted on 16 March 1967. Stage wiring continuity was verified by a total of 1979 individual point-to-point resistance measurements, specified in the test procedure by reference item numbers, "from" component, cable, plug, and pin designations, and "to" component, cable, plug, and pin designations. 1856 of the measurements were within the original resistance requirement of 1.0 ohm or less. For an additional 90 measurements, readings between 1.0 ohm and 3.0 ohms were accepted because of the length and type of wire involved. Another 33 measurements were accepted with readings of 50 $\pm$ 5 ohms, as these measurements were made through modules containing 49.9 ohm resistors.

Engineering comments noted that there were no parts shortages affecting the test. Thirteen revisions were made to the procedure for the following:

a. One revision noted the 90 measurements that were acceptable at 1.0 ohm to 3.0 ohms, because of wire types and lengths.

4.2.1 (Continued)

b. One revision noted the 33 measurements that were acceptable at 50 ± 5 ohms because the measurements were made through modules containing 49.9 ohm resistors.

c. Ten revisions changed nine measurement end point designations that were incorrect because of procedure and schematic errors. One of the revisions was written in error and was corrected by a subsequent revision.

d. One revision change three measurement end point designations because the umbilical cables were connected before the test was completed, making the original end points inaccessible.

Several problems were encountered and corrected during this test. The following discrepancies were corrected without requiring failure and rejection report action:

a. Plug 404W7P16 was connected to 404A75A10W3J1, while plug 404W7P15 was connected to 404A75A10W4J1. The connections should have been reversed. Also, the panel identification for A10A1 and A10A2 did not agree with the 404W7 wire harness installation. The conditions were corrected to meet drawing requirements. IIS 334409 covered this problem and rework.

b. At wire harness connector 404W208P38, wire D1561C22WHT was pulled loose from the socket of pin Z. The wire was reinserted correctly. IIS 334409 also covered this problem and rework.

c. A poor mating of connector 404A45W1P23 to bus module 404A43A23 caused two continuity measurements to vary from 2 ohms to 5 ohms. This was corrected and the measurements were acceptable. IIS 337305 covered this problem.

d. At wire harness connector 411W205P13, pin Z was recessed. The connector was removed and replaced to correct this condition. IIS 334571 covered this problem.

In addition to the above problems, the following failure and rejection reports were written during this procedure:

a. FARR A228562 noted that at location 404A62A214, pin C in plug P14 of wire harness 404A62W200, P/N 1B58249-1, was bent 10 degrees and recessed 1/8 inch. The bent pin was removed and replaced.

4.2.1 (Continued)

b. FARR A228564 noted that on decoder assembly 404A62A214, P/N 1A74053-503, S/N 270, the rubber insert of plug J2 was punctured between pins B and C. Decoder S/N 270 was removed and S/N 338 was installed. The defect was reworked to an acceptable condition, and decoder S/N 270 was accepted for further use.

4.2.2 Forward Skirt Thermo-Conditioning System Checkout Procedure (1B41926 B)

Before automatic checkout activities were started on Stage 504N, the forward skirt thermo-conditioning system was functionally checked by this procedure to prepare it for operation and to verify that the system was capable of supporting stage checkout operations. The particular items involved in this test were the forward skirt thermo-conditioning system, P/N 1B38426-513, and the GSE Model DSV-4B-359 thermo-conditioning servicer, P/N 1A78829-1.

Checkout of the forward skirt thermo-conditioning system was accomplished on 1 March 1967, and the procedure was certified as acceptable on 2 March 1967. After the preliminary setup of the Model 359 GSE servicer and an inspection of the forward skirt thermo-conditioning system for open bolt holes and properly torqued bolts, the thermo-conditioning system was purged with freon gas and then pressurized to 32 $\pm$ 1 psig with freon. A system leak check was conducted using a gaseous leak detector, P/N 1B37134-1, set to a sensitivity of 1 on the OZ/YR-R12 scale. No leakage was found at any of the system B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, or manifold flexible bellows.

The thermo-conditioning system was purged with gaseous nitrogen, and water/methanol coolant was circulated through the system. Coolant samples were taken from both the fluid sample pressure valve (system inlet), and the fluid sample return valve (system outlet), and checked for cleanliness, specific gravity, and temperature. The cleanliness analysis showed that the pressure valve sample had three particles in the 175 to 700 micron range, one particle in the 700 to 2500 micron range, and no particles over 2500 microns, while the return valve sample had one particle in the 175 to 700 micron range, and

4.2.2 (Continued)

no particles in the other ranges. This cleanliness was acceptable, as the maximum limits were twenty-five particles, five particles, and no particles, for the respective ranges. The specific gravity and temperature were acceptable at 0.901 and 60°F, respectively.

A differential pressure test was conducted by measuring the pressure difference between the thermo-conditioning system inlet and outlet while a coolant flowrate of 7.8 ± 0.1 gpm was maintained. The coolant temperature was also measured at the system inlet and outlet. Ten measurements, taken at two minute intervals, showed that the differential pressure varied from 15.0 psid to 15.3 psid, while the supply (inlet) temperature varied from 59°F to 62°F, and the return (outlet) temperature varied from 61°F to 66°F.

An air content test was performed by stabilizing the thermo-conditioning system coolant static pressure at 20 ± 0.5 psig, and draining sufficient fluid from the system to reduce the static pressure by 15 ± 0.5 psig. The quantity of fluid drained was measured as 42 cc, acceptably less than the 48 cc maximum permissible quantity for the five cold plate configuration of the thermo-conditioning system.

Engineering comments indicated that all parts were installed at the start of the test. No discrepancies or problems were noted during the test. Six revisions were made to the procedure for the following:

a. Four revisions added steps at various places in the procedure to verify that the R-12 freon bottle was not installed in the servicer when it was not needed, to verify that gaseous nitrogen and freon pressures were zero during servicer hose drying, to install the freon bottle when it was needed for the system leak check, and to remove the bottle after completion of the leak check. These steps eliminated the possibility of gaseous nitrogen flowing into the R-12 freon bottle, which would cause the bottle fuse plug to explode.

4.2.2 (Continued)

b. One revision added a step to enable the pneumatic purge shut-off valve to open completely when the servicer hoses were dried during the GSE servicer setup.

c. One revision added a step to fully open the facility gaseous nitrogen valve when purging the thermo-conditioning system after the leak check.

4.2.3 Forward Skirt Thermo-Conditioning System Operating Procedure (1B42124 A)

This manual procedure controlled the setup and normal daily operation of the GSE Model DSV-4B-359 thermo-conditioning servicer, P/N 1A78829-1, used to supply water/methanol coolant to the forward skirt thermo-conditioning system, P/N 1B38426-513. The water/methanol coolant provided the heat source or sink, as necessary, for proper operation of the forward skirt mounted electronic components during VCL checkout.

Initiated on 1 March 1967, the procedure was completed on 12 April 1967, and was certified and accepted on 13 April 1967. The forward skirt thermo-conditioning system was operated 42 times on 30 days during this period, for a total of 399.9 hours. The GSE servicer was setup for operation, and the coolant supply and return hoses, P/N's 1B37641-1 and -501, were verified to be connected between the servicer and stage thermo-conditioning system. The servicer fluid level was verified to be within the proper limits. The panels of the forward skirt thermo-conditioning system were inspected to verify that there were no open equipment mounting bolt holes. The servicer was purged with gaseous nitrogen, and the servicer power was applied.

For normal operation during VCL testing, the servicer was continuously purged with gaseous nitrogen to prevent any possible ignition of the methanol vapors within the servicer. When required for use, the servicer was turned on, and the fluid temperature control was adjusted to stabilize the supply temperature gauge reading between 80°F and 90°F. It was verified that the servicer flowmeter indicated 7.8 $\pm$ 0.3 gpm. The water lines, the servicer internal piping, the pressure and return hoses to the stage, and the stage system were visually checked for leakage. At 30 minute intervals during

4.2.3 (Continued)

automatic checkout operations, a check was made to verify that the supply temperature, the coolant flowrate, the coolant supply and return pressures, the gaseous nitrogen source pressure, and the servicer fluid level were within the proper limits, and that there was no leakage. At the end of each use, the servicer was shut down, and it was verified that the servicer filter differential pressure indicator buttons were down, and that the coolant pump was stopped with a flowrate of approximately zero gpm. At the conclusion of VCL testing, the servicer and thermo-conditioning system were secured by the Forward Skirt Thermo-Conditioning System Post-Checkout Procedure, H&CO 1B62965, (reference paragraph 4.2.34).

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during this procedure, and no failure and rejection reports were written. No revisions were made to the procedure.

4.2.4 Cryogenic Temperature Sensor Verification (1B64678 A)

This manual procedure verified the calibration and function of each stage cryogenic temperature sensor whose normal operating range did not include ambient temperature. These cryogenic temperature sensors are basically platinum resistance elements whose resistance changes with temperature according to the well known Callendar-Van Dusen equation. The particular sensors involved in this test are shown in Test Data Table 4.2.4.1.

The procedure was initially conducted on 1 and 2 March 1967, and was accepted on 2 March 1967. On 27 March 1967, transducer 406MT660, P/N 1A67862-505, S/N 241, measurement C368, was rejected because the required calibration curve was not available. (Reference FARR's A248635 and A248636). Replacement of this transducer required the removal and reinstallation of the LOX instrumentation probe, P/N 1A69275-509-002, S/N 3, and part of wire harness, P/N 1B42499-401.1, S/N 2. A second issue of the procedure was accomplished and accepted on 30 March 1967. Only those transducers associated with the LOX probe were checked during this second test.

For the check of each cryogenic temperature sensor, the ambient temperature at the time of the check was measured and recorded. The temperatures were 67°F and 68°F during the first test, and 66°F during the second test. For each sensor, the procedure specified a resistance value at 32°F and a sensitivity value. Using these values and the measured ambient temperature, the expected ambient resistance was calculated for each sensor. The actual ambient resistance of each sensor was then measured with a General Radio Model 1652A resistance limit bridge and compared to the calculated expected resistance. The measured resistance was verified to be within $\pm$ 5 per cent of the calculated resistance, except for sensors, P/N's 1A67862-513,

4.2.4 (Continued)

1A67862-533, 1A67863-537, and 1B34473-1, which were verified to be within ± 7 per cent of the calculated resistance. Test Data Table 4.2.4.1 shows the calculated and measured resistances for each of the cryogenic temperature sensors tested. After the resistance of each sensor was measured, the sensor wiring was verified to be correct by connecting a jumper wire on the adaptor cable, P/N 1B64095-1, and verifying that the sensor element was shorted out to a resistance measurement of 5 ohms or less.

Engineering comments indicated that all parts were installed at the start of the test for both issues of the procedure. No problems were encountered during the test, and no failure and rejection reports were written during either run of the test. Two revisions were made to the procedure:

a. One revision, written against both issues of the procedure, changed the reference designation of amplifier 404A64A220, P/N 1A82274-669, associated with the fuel pump discharge temperature, measurement C134. Due to a typing error the reference designation was listed as 404A64A200.

b. One revision, written only against the second issue of the procedure, deleted testing of sixteen sensors, as they were not affected by the LOX probe removal and the first issue test results were valid and acceptable.

4.2.4.1 Test Data Table, Cryogenic Temperature Sensor Verification

Measurement Number	Sensor P/N	Sensor S/N	Sensor Ref. Desig.	Resistance (ohms) Calculated	Resistance (ohms) Measured
C003	1B34473-1	307	403MT686	5385	5190
C004	1B34473-501	296	403MT687	1508	1534
C005*	1A67863-503	850	405MT612	537	544
C009	1A67863-535	1104	403MT653	215	220
C015	1A67863-509	1075	410MT603	1508	1520
C040*	1A67862-505	449	406MT613	1482	1510
C052	1A67862-513	565	408MT612	5396	5180
C057*	1A67862-501	51293	406MT606	537	543
C059*	1A67862-517	51425	406MT611	537	544
C133	NA5-27215T5	-	401(3MTT17)	1352	1370
C134	NA5-27215T5	-	401(3MTT16)	1352	1357
C159	1A67863-519	1115	424MT610	215	219
C161	1A67863-537	1097	404MT733	5385	5194
C208	1A67863-503	859	405MT605	538	543
C230	1A67863-509	1089	403MT706	1508	1530
C231	1A67863-529	626	403MT707	538	547
C256	1B37878-501	1055	409MT646	1508	1511
C257	1B37878-501	1250	409MT647	1508	1518
C368*	1A67862-505	51380	406MT660	1482	1508
C369*	1A67862-505	242	406MT661	1482	1500
C370	1B51648-507	59789	408MT735	5396	5256
C371	1B51648-507	59803	408MT736	5396	5226

* Second issue measurements.

4.2.5 Telemetry and Range Safety Antenna Systems Check (1B64679 A)

This procedure verified the integrity of the telemetry and range safety antenna systems by determining that the continuities, VSWR's, insertion losses, phasing, and power levels of the systems were all within the required limits. In addition, the center frequency and carrier deviation of the PCM transmitter were determined to be correct. The particular items involved in this test included:

Part Name	Reference Location	P/N	S/N
PCM RF Assembly	411A64A200	1B52721-509	33
Bi-Directional Coupler	411A64A204	1A69214-503	20012
Coaxial Switch	411A64A202	1A69213-1	72
Power Divider	411A64A201	1A69215-501	46
Telemetry Antennas	411E200 & E201	1A69206-501	69 & 72
Reflected Power Detector	411MT744	1A74776-501	2-0136
Forward Power Detector	411MT728	1A74776-503	0275
Dummy Load	411A64A203	1A84057-1	386
Directional Power Divider	411A97A56	1B38999-1	20
Hybrid Power Divider	411A97A34	1A74778-501	47
Range Safety Antennas	411E56 & E57	1A69207-501	39 & 40

Initiated on 2 March 1967, the procedure was completed on 20 March 1967, after seven days of activity. The procedure was certified and accepted on 28 March 1967. The tests in this procedure were generally performed by disconnecting various transmission lines in the telemetry and range safety RF systems, and determining the insertion losses and VSWR's for various segments of the systems. Measurements of the telemetry system components were made at 258.5 $\pm$ 0.1 MHz, while the range safety system components were measured at 450.0 $\pm$ 0.1 MHz. Before the systems tests were started, a test cable, P/N 1B50922-1, was calibrated for use during the tests, and the test cable VSWR was determined for both operating frequencies. These VSWR values, as well as other values measured during this test, are shown in Test Data Table 4.2.5.1.

4.2.5 (Continued)

Insertion loss measurements were made of the telemetry system transmission lines from the transmitter output of PCM RF assembly 411A64A200 to the input of each of the telemetry antennas, with the other antenna replaced by a 50 ohm load. The phasing difference of the transmission lines from the outputs of power divider 411A64A201 to the telemetry antenna inputs was measured with the antennas replaced by short circuit terminations. The VSWR's of the transmission lines from the power divider to the antennas were then measured with the antennas reconnected. Coaxial switch 411A64A202 was energized, and the telemetry system closed loop VSWR was measured from the transmitter output of PCM RF assembly 411A64A200 to the dummy loads. The coaxial switch was then de-energized, and the telemetry system open loop VSWR was measured from the PCM RF assembly output to the antennas.

On the range safety system, the transmission line center conductor dc continuity resistance was measured from the input of each range safety receiver to the output of each range safety antenna. The transmission line insulation resistances, measured between the center conductor and shield at both receiver inputs and both antenna outputs, were all infinite megohms, exceeding the 100 megohms minimum requirement. A series of insertion loss measurements were then conducted to find the isolation between the two receiver inputs, the insertion loss between each of the receivers and each of the antennas, the insertion loss between each of the receivers and the closed loop checkout connector of directional power divider 411A97A56, and the insertion loss in the closed loop checkout cable between the directional power divider and the forward umbilical. VSWR measurements were then made on the transmission lines from the outputs of hybrid power divider 411A97A34

4.2.5 (Continued)

to each of the antennas, and on the complete range safety system from the inputs of each receiver to the antennas.

The stage power was turned on for the PCM transmitter tests. A dummy load, P/N 1A84057-1, was connected to the output of the transmitter, and power was turned on to PCM RF assembly 411A64A200. Measurements were made of the transmitter center frequency and the carrier deviation for a plus and minus 5 vdc input signal. The transmitter RF output power into the dummy load was measured, and the dummy load was removed. The output of forward power detector 411MT728 was measured, and verified to be within ± 3 per cent of the calibration requirements of the unit for the transmitter RF power output. For calibration of the reflected power detector 411MT744, the forward power detector output was measured, and the equivalent forward power was determined from the detector calibration. The reflected power was also measured, using an HP431B power meter, and verified to be 11 ± 1 per cent of the forward power. The output of the reflected power detector was then measured, and verified to be within ± 3 per cent of the calibration requirement of the unit for the measured reflected power.

Engineering comments noted that there were no parts shortages affecting this test. One failure and rejection report was written during the test. FARR A228567 noted that PCM RF assembly 411A64A200, P/N 1B52571-509, S/N 33, had no output power. The output should have been 15 watts minimum. The unit operated properly during a retest, and was accepted for further use.

Five revisions were made to the procedure for the following:

a. Two revisions added the stage power setup, H&CO 1B66560-1, to the Applicable Documents list, and made it a prerequisite to the transmitter power tests, as it was required to establish the stage power-on condition.

4.2.5 (Continued)

b. One revision added the Model DSV-4B-267 instrument unit substitute, P/N 1A89817-1, to the End Item Equipment list, as switch selector commands were routed through the unit.

c. One revision added the switch selector, P/N 50M67864-5, as a cycle significant item, and required keeping a time/cycle data sheet (DAC Form 60-736) on this item.

d. One revision added a requirement for customer approval of all procedure revisions written during checkout.

4.2.5.1 Test Data Table, Telemetry and Range Safety Antenna System Check

Function	Measurement	Limits
Test Cable Calibration		
VSWR at 258.5 MHz	14.0	-
VSWR at 450.0 MHz	11.0	-
Telemetry System Tests		
Insertion Loss to Antenna 1 (db)	5.0	6.7 max.
Insertion Loss to Antenna 2 (db)	4.9	6.7 max.
Antenna Line Phase Difference (deg)	5.4	30. max.
VSWR to Antenna 1	1.5	1.7 max.
VSWR to Antenna 2	1.2	1.7 max.
Closed Loop System VSWR	1.3	1.5 max.
Open Loop System VSWR	1.09	1.7 max.
Range Safety System Tests		
Transmission Line Continuity Resistance		
Receiver 1 to Antenna 1 (ohms)	0.4	0.5 max.
Receiver 1 to Antenna 2 (ohms)	0.3	0.5 max.
Receiver 2 to Antenna 1 (ohms)	0.3	0.5 max.
Receiver 2 to Antenna 2 (ohms)	0.3	0.5 max.
Isolation and Insertion Loss Checks		
Receiver 1 to Receiver 2 Isolation (db)	32.	25. min.
Receiver 1 to Antenna 1 Loss (db)	5.4	6.0 max.
Receiver 1 to Antenna 2 Loss (db)	5.5	6.0 max.
Receiver 2 to Antenna 1 Loss (db)	5.0	6.0 max.
Receiver 2 to Antenna 2 Loss (db)	4.9	6.0 max.
Receiver 1 to Checkout Connector Loss (db)	24.2	24, +1.4, -1.0
Receiver 2 to Checkout Connector Loss (db)	24.3	24, +1.4, -1.0
Closed Circuit Checkout Cable Loss (db)	1.0	1.5 max.
VSWR Checks		
Power Divider to Antenna 1 Line VSWR	1.37	1.7 max.
Power Divider to Antenna 2 Line VSWR	1.44	1.7 max.
Receiver 1 System VSWR	1.3	1.7 max.
Receiver 2 System VSWR	1.25	1.7 max.

4.2.5.1 (Continued)

Function	Measurement	Limits
PCM Transmitter RF Tests		
Center Frequency (MHz)	258.497	258.500 ± 0.026
Carrier Deviation (KHz)	36.0	36.0 ± 3.0
Transmitter Output Power (watts)	28.5	15 min.
Forward Power Detector Output (millivolts)	142.5	142.5 ± 4.275
Forward Power Detector Output (millivolts)	156.5	-
Equivalent Forward Power (watts)	31.3	-
Reflected Power (watts)	3.4	3.443 ± 0.313
Reflected Power Detector Output (millivolts)	17.	17. ± 0.51

4.2.6 Umbilical Interface Compatibility Check (1B59782 D)

The integrity of the stage umbilical wiring was ensured by this procedure, through verification that the proper loads were present on all power buses, and that the control circuit resistances for propulsion valves and safety items were within the prescribed tolerances. The procedure involved the stage umbilical system electrical wiring and components.

This procedure was initiated on 2 March 1967, and was completed and accepted on 31 March 1967. Testing was active on four days during this period. A series of resistance measurements were made at specified test points on the GSE Model 463 signal distribution unit, P/N 1A59949-1, using test point 463A1A5J43-FF as the common point for all measurements. These measurements verified that all wires and connections in the umbilical cables, and in the stage umbilical system, were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits. A Simpson Model 260 multimeter was used to make the resistance measurements. The particular test points, circuit functions, measured resistances, and resistance limits are shown in Test Data Table 4.2.6.1.

Engineering comments noted that continuous vent module 411A32, P/N 1B67193-501, was not installed at the start of the test. On 28 March 1967, an interim use part, continuous vent module, P/N 1B51753-501-007, was installed in location 411A32 by SEO 1B67193-004. A jumper was installed between 411W6P32 and J3 of the interim use vent module, and this procedure was completed.

4.2.6 (Continued)

One other problem was encountered during this test. FARR A228563 was written against the engine control and bus switch module, P/N 1A74890-501, S/N 113. Two resistance checks involving this unit should have measured between 5 and 15 ohms each, but were measured as 50 ohms and 20 ohms. The module was replaced by S/N 105, and testing was completed satisfactorily.

Five revisions were written to the procedure, with two of these being voided. The remaining revisions were for the following:

a. One revision changed a 463A2 test point callout from A2J20-q to A2J29-q, to correct a procedure error.

b. One revision changed a requirement that "all values under 300 ohms be measured on the Rx1 resistance scale" to read "all values under 100 ohms", for greater accuracy with the Simpson Model 260 multimeter.

c. One revision voided a previous revision that had deleted a measurement at test point 463A2A2J30-Y, as the circuit had been reworked to drawing 1B67270 C, and the measurement was required.

4.2.6.1 Test Data Table, Umbilical Interface Compatibility Check

Reference Designation 463A2

Test Point	Function	Meas. Ohms	Limit Ohms
A2J29-C	Cmd., Ambient Helium Sphere Dump	26.	10-60
CB-8-2	Cmd., Engine Ignition Bus Power Off	Inf.	Inf.
CB-9-2	Cmd., Engine Ignition Bus Power On	7.5	5-15
CB-10-2	Cmd., Engine Control Bus Power Off	Inf.	Inf.
CB-11-2	Cmd., Engine Control Bus Power On	11.5	5-15
A2J29-N	Cmd., Engine Helium Emergency Vent Control On	45.	10-60
A2J29-P	Cmd., Fuel Tank Repress. Helium Dump Valve Open	33.	10-60

4.2.6.1 (Continued)

Test Point	Function	Meas. Ohms	Limit Ohms
A2J29-Y	Cmd., Start Tank Vent Pilot Valve Open	23.	10-60
CB4-2	Cmd., LOX Tank Cold Helium Sphere Dump	28.	10-60
A2J29-c	Cmd., LOX Tank Repress. Helium Sphere Dump	35.	10-60
A2J29-h	Cmd., Fuel Tank Vent Pilot Valve Open	45.	50 max.
	(Same, reverse polarity)	Inf.	500K min.
A2J29-i	Cmd., Fuel Tank Vent Valve Boost Close	45.	50 max.
	(Same, reverse polarity)	Inf.	500K min.
A2J29-g	Cmd., Ambient He. Supply Shutoff Valve Close	22.	10-60
A2J30-H	Cmd., Cold He. Supply Shutoff Valve Close	1.5K	1.5K max.
	(Same, reverse polarity)	Inf.	Inf.
A2J30-W	Cmd., LOX Vent Valve Open	45.	10-60
A2J30-X	Cmd., LOX Vent Valve Close	45.	10-60
A2J30-Y	Cmd., LOX and Fuel Prevalve Emergency Close	55.	100 max.
	(Same, reverse polarity)	Inf.	Inf.
A2J30-Z	Cmd., LOX and Fuel Chilldown Pilot Valve Open	45.	10-60
A2J30-b	Cmd., LOX Fill & Drain Valve Boost Close	20.	10-30
A2J30-c	Cmd., LOX Fill & Drain Valve Open	20.	10-30
A2J30-d	Cmd., Fuel Fill & Drain Valve Boost Close	20.	10-30
A2J30-e	Cmd., Fuel Fill & Drain Valve Open	20.	10-30
A2J42-F	Meas., Bus +4D111 Regulation	150.	100-200
A2J35-y	Meas., Bus +4D141 Regulation	120.	50-150
A2J6-AA	Sup., 28v Bus +4D119 Talkback Power	85.	60-100

4.2.6.1 (Continued)

Reference Designation 463A1

Test Point	Function	Meas. Ohms	Limit Ohms
A5J41-A	Meas., Bus +4D131 Regulation	200.	200-500
A5J41-E	Meas., Bus +4D121 Regulation	2.6K	1.6K min.
A5J53-AA	Sup., 28v +4D119 Forward Talkback Power	75.	60-100

4.2.7 Engine Alignment Procedure (1B39126 A)

The engine alignment procedure verified that the exit plane of the J-2 engine thrust chamber was properly aligned with respect to the S-IVB stage structure. The particular items involved in this test were the J-2 engine, P/N 103826, S/N J2094; the hydraulic pitch actuator 403A71A1, P/N 1A66248-505-011, S/N 52; the hydraulic yaw actuator 403A72L1, P/N 1A66248-505-011, S/N 63; and the stage, P/N 1A39300-507, S/N 1009.

The engine alignment verification was satisfactorily accomplished on 3 March 1967, and the procedure was accepted on the same date. A Wild N-3 alignment scope was first used to determine the difference in elevation of datum plane "G" at four locations around the stage periphery. Datum plane "G" was defined as the mating surface between the aft skirt and the handling ring. The elevations at the four locations were determined to be 2.000 inches, 1.989 inches, 2.010 inches, and 1.995 inches. The maximum deviation between any two locations was 0.015 inches, well within the 0.062 inches maximum deviation limit.

The engine bell protective cover, P/N RX20810-21, was loosened and moved upward about 6 inches, and the engine closure, P/N RX20941-11, was removed. The engine exit plane alignment fixture, P/N 1B54581-1, was positioned and attached to the J-2 engine exit flange, and two clinometers, P/N 1B29613-1, were positioned on the machined surface block at the center of the fixture. From the clinometer readings, the pitch plane adjusted angle was found to be 0.6 minutes low toward stage position I, and the yaw plane adjusted angle was found to be 3.0 minutes low toward stage position IV. From these measurements, the adjusted exit plane inclination angle was determined to be 3.06 minutes, with the low quadrant between stage positions I and IV. This

4.2.7 (Continued)

inclination angle was well within the maximum inclination limit of 21 minutes. At the completion of this check, the test hardware was removed, the engine protective cover was repositioned, and the engine closure was reinstalled.

Engineering comments indicated that there were no parts shortages affecting this test. No problems were encountered during this procedure, and no failure and rejection reports were written. One revision was made to the procedure. The test steps that measured and adjusted the hydraulic actuator lengths were all deleted, as these adjustments were made per drawing 1B66209 prior to installation of the actuators. As the final inclination angle was well within the allowable tolerance, readjustment of the actuators was not required.

4.2.8 Stage Power Setup (1B66560 A)

Prior to initiating any other automatic test procedures, the stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage, and ensured that the stage forward and aft power distribution system was not subjected to excessive static loads during initial setup sequences. Once the procedure was successfully accomplished, it was used to establish initial conditions during subsequent automatic procedures throughout the VCL testing.

This procedure was initially conducted on 6 March 1967 to verify the operation of the procedure and the equipment. Several minor problems and a number of digital data tape errors were corrected, and the procedure was held open for use during the subsequent VCL operations. A second acceptance test run was satisfactorily accomplished on 8 April 1967, after completion of the all systems test, and the procedure was accepted on 13 April 1967. The following narration and the measurement values shown in Test Data Table 4.2.8.1 are from this last acceptance test run.

The test started by resetting all of the matrix magnetic latching relays, and verifying that the corresponding command relays were in the proper state. Verification was made that the umbilical connectors were mated, and that plugs 404W26P1 and 404W27P1 were disconnected from the LOX and LH_2 inverters. The bus 4D119 talkback power was turned on, and the prelaunch checkout group was turned off. The forward power, bus 4D11 power, and bus 4D41 power were transferred to external power. The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propulsion level sensor power were all verified to be OFF. The range safety system 1 and 2 receiver powers and EBW firing unit powers were all transferred to

4.2.8 (Continued)

external and verified to be OFF. The switch selector checkout indication enable and the flight measurement indication enable were both turned on. The bus 4D131 28 vdc power was turned on, and the forward bus 1 initial current and voltage were measured.

The range safety safe and arm device was verified to be in the SAFE condition. The engine start pilot relay, the LOX and LH_2 chilldown pump pilot relays, the auxiliary hydraulic pump flight mode and coast mode relays, the LOX flight pressure coast period relay, and the 70 pound ullage pilot relay, were all verified to be reset. The propellant utilization system power and inverter and electronics power, the PCM system group power, the environmental control group power, the propellant utilization system boiloff bias, and the PCM RF group power, were all verified to be OFF. The EBW ullage rocket relay was verified to be reset. The switch selector functions were turned off, and the engine cutoff was verified to be OFF. The forward bus 1 quiescent current was measured.

The cold helium shutoff valve was closed. The bus 4D111 28 vdc power was turned on, and the aft bus 1 current and voltage were measured. The sequencer power was turned on, the PCM system group power was turned on, and the PCM system group current was measured. The bus 4D121 28 vdc power was turned on, the forward bus 2 current was verified to be less than 2 amperes, and the forward bus 2 voltage was measured. The prelaunch checkout group power was turned on, and the checkout group current was measured. The RACS run mode was turned on, and the forward and aft battery load test was turned off. The DDAS ground station source selector switch was manually set to position 1, and the ground station was verified to be in synchronization. The EBW pulse sensor power was turned off.

4.2.8 (Continued)

A series of checks verified that stage functions were in the proper state. Thirty-five functions were verified to be OFF, and fifteen functions were verified to be ON. The LOX and LH_2 tank valves were also verified to be in the proper OPEN or CLOSED positions. The range safety EBW firing unit charging voltages were measured, the aft bus 2 voltage was measured, and the voltages of the aft 5 volt excitation module and both forward 5 volt excitation modules were measured. This completed the stage power setup, and established the initial conditions for the other automatic procedures.

Engineering comments noted that three parts were not installed at the start of this test. As noted below, installation of these parts was accomplished prior to the second acceptance test run of this procedure.

a. Continuous vent module 411A32, P/N 1B67193-501, was not installed. An interim use part, continuous vent module, P/N 1B51753-501-007, S/N 9, was installed on 28 March 1967, by SEO 1B67193-004, for use during VCL testing.

b. LH_2 vent and relief valve 411A1, P/N 1A48257-511, S/N 39, was installed on 6 March 1967, after the first test run of this procedure was completed.

c. Directional control valve 411A29, P/N 1A49988-1, S/N 23, was installed on 20 March 1967, after a previously installed interim use part was removed.

One failure and rejection report was written against this procedure. FARR A248641 noted that a relief over-ride open solenoid on the interim use fuel tank continuous vent module, P/N 1B51753-501-007, S/N 9, was energized for over 1/2 hour. Per the propellant tank system leak check, H&CO 1B59459, the maximum allowable energized duration was 10 seconds. As no damage was apparent, and as the interim use module was to be replaced after VCL checkout, the vent module was accepted for use.

4.2.8 (Continued)

Eight revisions were made to the procedure for the following:

a. One revision added the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the Mandatory End Items list, and deleted it from the Optional End Items list, to correct a procedure error.

b. One revision added the Model DSV-4B-240 telemetry systems display console, P/N 1A69003-1, to the Optional End Items list, to correct a procedure error.

c. One revision added instructions for the setup of the GSE Model 123 DDAS ground station, to correct a procedure error.

d. One revision deleted the LH_2 injector temperature OK bypass relay reset function from the program "off" function buffer table, as this was an "on" function.

e. Two revisions made some fifty changes and revisions to the digital data tape, P/N 1B66777G, to correct the tape for proper use with this program.

f. One revision changed a function number from 1764 to 2707, as the program was interrogating an SIB function number, rather than an SV function number.

g. One revision connected jumpers from 411W6P32 to J3 on the interim use fuel tank continuous vent valve module, P/N 1B5173-501-007, connecting pin E of P32 to pin A of J3, and pin D of P32 to pin C of J3, as the interim use module had a 3 pin connector at J3, instead of a 6 pin connector as was on the flight use module. The jumpers were to be removed when the interim use item was removed.

4.2.8.1 Test Data Table, Stage Power Setup

Function	Measured Value	Limit
Forward Bus 1 Initial Current (amp)	4.9	20. max.
Forward Bus 1 Voltage (vdc)	28.2	28. ± 2
Forward Bus 1 Quiescent Current (amp)	0.30	5. max.
Aft Bus 1 Current (amp)	0.00	10. max.
Aft Bus 1 Voltage (vdc)	28.04	28. ± 2
PCM System Group Current (amp)	4.00	8. max.
Forward Bus 2 Voltage (vdc)	28.16	28. ± 2
Prelaunch Checkout Group Current (amp)	1.60	12. max.
Range Safety 1 EBW Firing Unit Charge Voltage (vdc)	0.005	0.0 ± 1.0
Range Safety 2 EBW Firing Unit Charge Voltage (vdc)	0.010	0.0 ± 1.0
Aft Bus 2 Voltage (vdc)	0.000	0.0 ± 2.0
Aft 5v Excitation Module Voltage (vdc)	5.001	5.0 ± 0.030
Forward 5v Excitation Module 1 Voltage (vdc)	4.986	5.0 ± 0.030
Forward 5v Excitation Module 2 Voltage (vdc)	4.987	5.0 ± 0.030

4.2.9 Stage Power Turnoff (1B66561 A)

The stage power turnoff procedure shut down the stage power distribution system after completion of various system checkout procedures during VCL testing, and returned the stage to the de-energized condition. All stage relays were deactivated so that no current flowed from the battery simulators through the stage wiring, and all internal-external transfer relays were set to the external condition.

This procedure was satisfactorily accomplished on 6 March 1967, and was accepted on 9 March 1967. Following this, the procedure was used to shut down the stage after subsequent automatic procedures during VCL testing.

It was verified that the umbilical connectors were mated, and that the flight measurement indication enable was turned on. Verification was made that the bus 4D119 talkback power, the bus 4D131 and 4D111 28v powers, and the sequencer power were all on. The bus 4D31 and 4D11 voltages were verified to be 28 $\pm$ 2.0 vdc. The switch selector functions were turned off, and a series of checks verified that the stage functions were in the proper state of OFF or RESET, that the stage bus powers were off, and that the bus voltages were 0 $\pm$ 1.0 vdc. The EBW pulse sensor power was turned off, and the range safety receiver 1 and 2 powers and EBW firing unit 1 and 2 powers were transferred to external. The range safety safe and arm device was verified to be in the SAFE condition, and the bus 4D119 talkback power was turned off. The matrix magnetic latching relays were then reset, completing the stage power turnoff. It was noted that the switch selector was used 54 times during this procedure.

4.2.9 (Continued)

Engineering comments noted that there were no parts shortages affecting this procedure. No problems were encountered during this test, and no failure and rejection reports were written. Three revisions were written to this procedure for the following:

a. One revision added the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the Mandatory End Items list, and deleted it from the Optional End Items list, as it was a mandatory use item.

b. One revision added a program step to verify that the flight measurements indication enable command, function 412, was set, to correct a procedure omission.

c. One revision deleted a command test step from the talkback bus malfunction fault isolation subroutine, as the command test was not associated with the talkback bus malfunction.

4.2.10 Signal Conditioning Setup (1B64681 A)

This procedure calibrated the stage 5 volt and 20 volt excitation modules prior to the use of the stage instrumentation system, and calibrated any items of the stage signal conditioning equipment that were found to be out of tolerance during testing. The signal conditioning equipment consisted of those items required to convert transducer low level or ac signals to the 0 to 5 vdc form used by the telemetry system, and included dc amplifiers, temperature bridges, frequency to dc converters, and expanded scale voltage monitors. Only the particular items calibrated during this procedure are noted below and in Test Data Table 4.2.10.1. During computer holds, this procedure was also used as required to troubleshoot instrumentation problems.

The procedure was initiated on 6 March 1967, and most of the necessary calibrations were completed by 20 March 1967, after five days of activity. The procedure was then held open for use as required during subsequent VCL activity. One additional calibration was accomplished on 10 April 1967, and the procedure was closed out and accepted on 13 April 1967. The stage power setup, H&CO 1B66560, was performed prior to any calibration activity, to provide electrical power to the equipment.

Three 5 volt excitation modules were calibrated, using test assembly, P/N 1B50931-1, and adapter cables, P/N 1B54632-1 and -501, and 1B55715-511, -513, -517, and -523, connected between each module and the stage wiring. The input voltage to each module was verified to be 28 $\pm$ 0.1 vdc. On each module, control R20 was adjusted to obtain a 5 vdc output of 5.000 $\pm$ 0.005 vdc, control R23 was adjusted to obtain a -20 vdc output of -20.000 $\pm$ 0.005

4.2.10 (Continued)

vdc, and, with test assembly switch S4 in position 1, control R27 was adjusted to obtain an ac output of 10 ± 1 volts peak-to-peak at 2000 ± 20 Hz. A Tektronix Model 545 oscilloscope, a Fluke Mode 825 differential voltmeter, and an HP5245L frequency counter were used to make these measurements. The final values measured, as shown in the Test Data Table, were all within the above limits. The ac output measurements were repeated with test assembly switch S4 in positions 2, 3, and 4, and were found to be the same as for position 1.

Six 20 volt excitation modules were calibrated, using adapter cable, P/N 1B50940-1, connected between each module and the stage wiring. On each module, coarse control R7 and fine control R5 were adjusted to obtain an output of 20.000 ± 0.005 vdc, as measured with a Fluke Model 825 differential voltmeter. As shown in the Test Data Table, the final value measured for each module was within the above limits.

Only one temperature bridge required calibration. This was temperature bridge 404A64A207, P/N 1A98088-501, S/N 120, for the gaseous hydrogen start bottle temperature, measurement C6. Manual checkout decoder assembly, P/N 1B50927-1, and adapter cables, P/N 1B55715-1 and -501, were connected between the stage wiring and connector J1 of channel decoder assembly 404A64A214, P/N 1A74053-501, and adapter cable, P/N 1B64101-1, was connected between the stage wiring and connector J2 of the temperature bridge. With manual checkout decoder switch S2 set to "L", the temperature bridge potentiometer R5 was adjusted to obtain a bridge output of 0.000 mvdc, within the 0.000 ± 0.05 mvdc limits. With switch S2 set to "H", the bridge output was measured as 24.18 mvdc, within the 24.0 ± 0.3 mvdc limits. The measurements were made with a Fluke Model 825 differential voltmeter.

4.2.10 (Continued)

Two low gain dc amplifiers were calibrated, using the instrumentation checkout console assembly, P/N 1B28115-1, to control RACS commands, and using the console digital voltmeter to measure the amplifier outputs. The low RACS command was turned on, and the amplifier zero control R7 was adjusted to obtain the proper zero output. Then the high RACS command was turned on, and the amplifier gain control R17 was adjusted to obtain the proper gain output. Finally, the run mode RACS command was turned on, and the amplifier run bias output was verified to be within the proper limits. For the fuel boiloff bias voltage, measurement M10, amplifier 411A61A256, P/N 1A94910-505.1, S/N 322, the zero output was 1.001 vdc, within the 1.000 $\pm$ 0.100 vdc limits; the gain output was 4.001 vdc, within the 4.000 $\pm$ 0.100 vdc limits; and the run bias output was 0.000 vdc, within the 0.000 $\pm$ 0.025 vdc limits. For the PCM/FM transmitter output power, measurement N18, amplifier 411A61A257, P/N 1A94910-507, S/N 323, the zero output was 1.002 vdc, within the 1.000 $\pm$ 0.005 vdc limits; the gain output was 3.999 vdc, within the 4.000 $\pm$ 0.005 vdc limits; and the run bias output was 0.013 vdc, within the 0.000 $\pm$ 0.020 limits.

One expanded scale voltage monitor module was calibrated by calibrating the associated dc amplifier. This was the static inverter-converter 5 vdc monitor, measurement M4, expanded scale voltage module 411A61A255, P/N 1A95181-1, S/N 121, and dc amplifier 411A61A254, P/N 1A82395-1, S/N 2300. The instrumentation checkout console assembly, P/N 1B28115-1, was used to control RACS commands, and the console digital voltmeter was used to measure the amplifier output. The low RACS command was turned on, and the dc amplifier zero control was adjusted to obtain a zero output of 0.001 vdc,

4.2.10 (Continued)

within the 0.000 ± 0.005 vdc limits. The high RACS command was then turned on, and the amplifier gain control was adjusted to obtain a gain output of 3.998 vdc, within the 4.000 ± 0.005 vdc limits. The run mode RACS command was turned on after the calibration was completed.

Two 400 Hz expanded scale frequency to dc converters were calibrated. Adapter cable, P/N 1B50934-1, connected an HP205AG frequency generator to connector J3 of the converter module to supply input frequencies, while the digital voltmeter on instrumentation checkout console assembly, P/N 1B28115-1, was used to measure the converter output voltage. The frequency generator was adjusted for an output of 410 ± 0.05 Hz. at 2.5 ± 0.1 vrms, and control R3 on the frequency to dc converter module was adjusted to obtain a 5.00 ± 0.01 vdc module output. The frequency generator was then adjusted for an output of 390 ± 0.05 Hz at 2.5 ± 0.1 vrms, and control R9 on the converter module was adjusted to obtain a 0.00 ± 0.01 vdc module output. As shown in the Test Data Table, the final values measured were all within the above limits.

No parts shortages were recorded affecting this test. One failure and rejection report was written during this test. FARR A228566 noted that 20 volt excitation module 404A63A241, P/N 1A74036-1.1, S/N 282, had an output of 26.658 vdc, and could not be adjusted to the required 20.000 ± 0.005 vdc output. The unit was removed, and a new part, S/N 289, was installed.

Twelve revisions were made to the procedure for the following:

a. One revision specified H&CO drawing 1B66560-1 as the applicable stage power setup to be used for this procedure.

4.2.10 (Continued)

b. One revision completed the Running Time/Cycle Record requirements by adding the requirement for keeping time/cycle data sheets, DAC form 60-736, on the cycle significant switch selector, P/N 50M67864-5.

c. Two revisions corrected statements specifying which parts of the test required the use of 100K resistors in parallel with the Fluke Model 825 differential voltmeter, and which parts of the test required the use of adapter cables with the manual checkout decoder.

d. One revision deleted the instructions for manually turning on power for the signal conditioning equipment, as the stage power setup, H&CO 1B66560, was required to be performed for this purpose.

e. Four revisions corrected procedure typing errors.

f. One revision corrected a measurement tolerance from 2.5 $\pm$ 0.3 vrms to be 2.5 $\pm$ 0.1 vrms to agree with the tolerance requirement on the input signal to the 400 Hz. frequency to dc converters.

g. One revision added the proper connector designation and test cable dash number that were omitted from one step of the procedure.

h. One revision added a notation that adapter cable, P/N 1B55715-511, was not used during calibration of the 5 volt excitation module 411A98A2, (forward 2), as, for this unit, the stage wiring had no connection at J3, where the cable normally connected.

4.2.10.1 Test Data Table, Signal Conditioning Setup

5 Volt Excitation Module, P/N 1A77310-503.1

Reference Location	S/N	5 vdc Out. (vdc)	-20 vdc Out. (vdc)	ac Output (vpp)	(Hz)
411A99A33	132	5.001	-19.998	10.2	2001
411A98A2	131	5.003	-20.002	10.0	2014
405A52A7	136	5.002	-19.997	10.0	2002

20 Volt Excitation Module, P/N 1A74036-1.1

Reference Location	S/N	20 vdc Output (vdc)
411A61A242	264	20.000
404A62A241	284	19.999
404A63A241	289	19.999
404A64A241	283	20.002
404A65A241	278	19.999
404A63A233	258	20.003

400 Hz Frequency to dc Converter Module, P/N 1B37523-1.3

Function	Meas. No.	Reference Location	S/N	Output (vdc) 410 Hz	390 Hz
Static Inverter-Converter	M12	404A65A233	64	5.003	0.005
LH_2 Chilldown Inverter	M28	404A65A205	31	4.999	0.001

4.2.11 Level Sensor and Control Unit Calibration (1B64680 A)

This manual procedure determined that the control units associated with the LOX and LH_2 liquid level sensors, point level sensors, fast fill sensors, and overfill sensors, were adjusted for an operating point well within the limits of the capacitance change caused by a simulated wet condition of the sensors. The particular items involved in this test are noted in Test Data Table 4.2.11.1

The procedure was satisfactorily accomplished on 6 March 1967, and was accepted on the same date. The point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, General Radio type 1422 CD, were used during the test to provide capacitance changes to the control units as required to simulate sensor wet conditions, and to determine the control unit operating points.

The manual checkout assembly was connected between each of the control units to be checked and its associated sensor, and the precision capacitor was connected to the checkout assembly to parallel the sensor capacitance. A voltmeter was connected to the appropriate checkout assembly test points to measure the control unit output signal. To establish the operating point for the control unit under test, the precision capacitor was set for the appropriate calibration capacitance to simulate a wet condition for the associated sensor. These calibration capacitances were 0.7 $\pm$ 0.01 picofarads for all LH_2 sensors except the LH_2 overfill sensor, which required 1.1 $\pm$ 0.02 picofarads, and 1.5 $\pm$ 0.02 picofarads for all LOX sensors except the LOX overfill sensor, which required 2.1 $\pm$ 0.02 picofarads. The control unit power was then turned on, and the control point adjustment control, R1, on the unit under test was adjusted until the control unit output signal just

4.2.11 (Continued)

changed from 0 ± 1.1 vdc to 28 ± 2.0 vdc, indicating activation of the control unit output relay.

The capacitance of the precision capacitor was then decreased until the control unit output signal changed to 0 ± 1.1 vdc, indicating deactivation of the control unit output relay. The deactivation capacitance value was recorded. The capacitance of the precision capacitor was then increased until the control unit output signal changed to 28 ± 2.0 vdc, indicating reactivation of the control unit output relay. The reactivation capacitance value was also recorded. The recorded capacitance values for each control unit, and the appropriate operating point minimum and maximum capacitance limits, are shown in Test Data Table 4.2.11.1.

Following the capacitance checks on each control unit, a series of checks verified the operation of the output relay. With the associated sensor disconnected, the relay was verified to be deactivated under both normal and test conditions. With the sensor connected, the relay was verified to be deactivated under normal conditions and activated under test conditions.

Engineering comments indicated that there were no parts shortages that affected this test. No problems were encountered during the test, and no failure and rejection reports were written. Two revisions were made to the procedure for the following:

a. One revision corrected a procedure error by changing an incorrect reference location designation from 404A63A239 to the proper designation 404A63A227.

b. One revision added a step at four places in the procedure to operate the checkout assembly TEST switch and POWER switch to the OFF position before disconnecting cables. This was to prevent damage to the control units.

Function	Sensor, P/N 1A68710 Ref. Loc.	Dash P/N	S/N	Control Unit, P/N 1A68710 Ref. Loc.	Dash P/N	S/N	Deact. Cap. (pf) Meas.	Min.	React. Cap. (pf) Meas.	Max.
-LH_2 Tank-	408-			411-						
Liq. Lev. L17	MT732	-507	D68	A61A217	-509	D68	0.676	0.5	0.682	0.9
Liq. Lev. L18	MT733	-507	D69	A61A219	-509	D73	0.672	0.5	0.676	0.9
Liq. Lev. L19	MT734	-507	D70	A61A221	-509	D74	0.664	0.5	0.666	0.9
Pt. Lev. 1	A2C1	-507	D38	A92A25	-509	D101	0.656	0.5	0.658	0.9
Pt. Lev. 2	A2C2	-507	D57	A92A26	-509	D90	0.682	0.5	0.684	0.9
Pt. Lev. 3	A2C3	-507	D62	A92A27	-509	D87	0.687	0.5	0.689	0.9
Pt. Lev. 4	A2C4	-507	D66	A61A201	-509	D100	0.650	0.5	0.652	0.9
Fast Fill	A2C5	-1	E149	A92A43	-509	D84	0.670	0.5	0.672	0.9
Overfill	*	*	*	A92A24	-509	D92	1.063	0.9	1.066	1.3
-LOX Tank-	406-			404-						
Liq. Lev. L14	MT657	-1	E143	A63A221	-511	D77	1.463	1.3	1.465	1.7
Liq. Lev. L15	MT658	-1	E135	A63A206	-511	D84	1.491	1.3	1.492	1.7
Liq. Lev. L16	MT659	-1	D86	A63A223	-511	D79	1.455	1.3	1.458	1.7
Pt. Lev. 1	A2C1	-1	D18	A72A1	-511.1	D101	1.439	1.3	1.443	1.7
Pt. Lev. 2	A2C2	-1	E67	A72A2	-511.1	D80	1.437	1.3	1.443	1.7
Pt. Lev. 3	A2C3	-1	D88	A72A3	-511.1	D100	1.443	1.3	1.445	1.7
Pt. Lev. 4	A2C4	-1	E99	A63A227	-511	D111	1.446	1.3	1.448	1.7
Fast Fill	A2C5	-1	D97	A72A5	-511.1	E12	1.373	1.3	1.377	1.7
Overfill	**	**	**	A72A4	-511.1	D50	2.020	1.9	2.022	2.3

* Part of LH_2 Mass Probe 408A1, P/N 1A48431-505, S/N D3.

** Part of LOX Mass Probe 406A1, P/N 1A48430-509-010, S/N C1.

4.2.12 Digital Data Acquisition System Calibration (1B66563 A)

This procedure provided the manual and automatic operations for the checkout and calibration of the digital data acquisition system (DDAS), to prepare the system for use during VCL checkout activities. The integrity of the DDAS was verified from data inputs, through the various multiplexers and the PCM/DDAS assembly, to the DDAS ground station. The particular components of the digital data acquisition system involved in this test were the PCM/DDAS assembly 411A97A200, P/N 1A74049-511, S/N 14; the Model 270 time division multiplexers 404A61A200 (CP1-B0), P/N 1B62513-529, S/N 19, and 404A61A201 (DP1-B0), P/N 1B62513-513, S/N 3; the Model 1D remote digital submultiplexer (RDSM) 404A60A200, P/N 1B52894-1, S/N 9; and the Model 102 low level remote analog submultiplexer (RASM) 404A60A201, P/N 1B54062-503, S/N 21.

The procedure was initiated on 7 March 1967, and was satisfactorily completed and accepted by the fourth test run on 13 March 1967, after five days of activity. The first three test runs were not successful because of problems with the PCM/DDAS assembly and the CP1-B0 multiplexer, as noted below. On 4 April 1967, additional problems were encountered with the CP1-B0 multiplexer during the DDAS automatic checkout, H&CO 1B66564, (reference FARR A248644 under paragraph 4.2.18). The multiplexer was replaced, and a second issue of this calibration procedure was accomplished on 4 and 5 April 1967 to check this multiplexer only. The second issue was accepted on 6 April 1967. The following narration covers both the fourth test run of the first issue of the procedure, and the parts of the test conducted by the second issue of the procedure.

After the stage power setup was accomplished, and initial conditions were established, the manual 72 kHz bit rate test was conducted. The DDAS ground

4.2.12 (Continued)

station was verified to be in synchronization with the stage DDAS, and the DDAS 72 kHz clock bit rate was measured as 72,005 bits per second, well within the 71,975 to 72,025 bits per second requirements. Test connections were then made to the PCM/DDAS assembly to manually measure the output frequency and voltage of the 600 kHz VCO, used to transmit data from the stage DDAS to the DDAS ground station over hardwire circuits. The upper bandedge of the 600 kHz VCO was measured as 633.2 kHz at 2.8 vrms, meeting the requirements of 623.2 to 643.2 kHz, with 633.2 kHz nominal, at greater than 2.2 vrms. The lower bandedge was measured as 567.9 kHz at 2.9 vrms, meeting the requirements of 556.8 to 576.8 kHz at greater than 2.2 vrms. The VCO deviation, found as the difference between the bandedge frequencies, was 65.3 kHz, within the 70 $\pm$ 10 kHz deviation limits.

An automatic flight calibration test was conducted on both the CP1-B0 and DP1-B0 multiplexers. The outputs of data channels DP1-B0-11-01 through -11-10, and CP1-B0-11-01 through -11-10 were recorded at each of the calibration input levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc. The output of each of these channels was within the $\pm$ 0.030 vdc tolerance limit of the input for each calibration level.

The CP1-B0 and DP1-B0 multiplexers were then checked individually. For testing of the CP1-B0 multiplexer 404A61A200, the required manual test cable connections were made, and, when called for by the computer typeout, the multiplexer input signal power supply was adjusted to voltage levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc, each $\pm$ 0.001 vdc, for the five test runs on this multiplexer. During the 0.000 vdc input level test run only, input

4.2.12 (Continued)

voltages of 4.5 ± 0.100 vdc and 20.0 ± 1.0 vdc were supplied to the PCM/DDAS assembly 411A97A200. These inputs were 0.0 ± 0.100 vdc and 0.0 ± 1.0 vdc, respectively, during the other four test runs. For testing of the DP1-B0 multiplexer 404A61A201, the required test cable connections were made, and, when called for by the computer typeout, the multiplexer input signal power supply adjustments were repeated for the five test runs on this multiplexer. All channel outputs for both multiplexers were within the applicable tolerance of the applied inputs, generally ± 0.025 vdc or ± 0.03 vdc.

For testing of the remote digital submultiplexer 404A60A200, the required manual test cable connections were made, all RDSM test switches on the RDSM-RASM checkout kit, P/N 1B64402-1, were placed in the OFF position, and the RDSM input signal power supply was adjusted to 20 ± 1 vdc. When required by the computer typeout for each of the ten test runs on this submultiplexer, nine of the ten RDSM test switches were placed in the OFF position, while one of the test switches was placed in the ON position. Only switch SW1 was ON for run 1, only switch SW2 was ON for run 2, etc. The RDSM outputs were in the proper state for each of the ten test runs for this unit.

For testing of the remote analog submultiplexer 404A60A201, the required manual test cable connections were made, and, as required by the computer typeout, the RASM input signal power supply was adjusted to voltage levels of 0.00, 10.00, 20.00, and 30.00 millivolts dc, ± 0.015 millivolts dc each, for the four test runs on this submultiplexer. All channels of the RASM were within the required ± 0.035 vdc tolerance of the 0.000, 1.667, 3.333, and 5.000 vdc respective nominal output levels.

4.2.12 (Continued)

The CP1-B0 multiplexer installed during the above tests, P/N 1B62513-529, S/N 17, was rejected during the DDAS automatic checkout, and was replaced by S/N 19. The second issue of this procedure performed only the multiplexer flight calibration and CP1-B0 multiplexer checkout parts of the procedure, as above, to check the replacement unit. During the flight calibration test, seven channels on the CP1-B0 multiplexer indicated 4.969 vdc rather than the required 5.000 ± 0.030 vdc. All other channel outputs were within the required limits, as were all channel outputs during the CP1-B0 multiplexer individual tests. The multiplexer was rejected by FARR A248645, noted below, but was retained on the stage for use during the remainder of VCL checkout. The output tolerance for the flight calibration test was widened to ± 0.031 vdc by FARR A248645 and WRO S-IVB-3356 to permit continued use of the multiplexer.

Engineering comments noted that the following parts were not installed at the time of this test. These items affected only the initial conditions scan, and did not interfere with the test operations.

a. The continuous vent module 411A32, P/N 1B67193-501, was not installed. An interim use item, P/N 1B51753-501-007, was installed per SEO 1B67193-004 before the second issue of the procedure was conducted.

b. The LOX vent and relief valve 424A1, P/N 1A49590-515, was not installed. An interim use item, P/N 1A49590-513-018, was installed per SEO 1A49590-018 during both issues of the procedure.

c. The LH_2 vent and relief valve 411A1, P/N 1A48257-511, and the directional control valve 411A29, P/N 1A49988-1, were not installed at the start of this procedure, but were installed and tested on 10 March 1967, prior to the completion of the test.

4.2.12 (Continued)

Out-of-tolerance channel readings encountered during this procedure required the following failure and rejection reports:

a. FARR A228565 noted that the PCM/DDAS assembly 411A97A200, P/N 1A74049-511, S/N 3, had an output of 5.035 to 5.056 vdc. The output should have been 5.000 ± 0.030 vdc. The unit was removed, reconfigurated to P/N 1B52720-501, and resubmitted for rework. PCM/DDAS assembly, P/N 1A74049-511, S/N 14, was installed on the stage.

b. FARR A228568 noted that the output of multiplexer 404A61A200, P/N 1B62513-529, S/N 19, was intermittently 4.969 vdc. The output should have been 5.000 ± 0.030 vdc. Laboratory retest did not confirm the defect, but the problem repeated during testing on the stage. During stage troubleshooting, 28 vdc was inadvertently applied to pin E of connector J6, the calibrator 5 vdc input. The unit was removed and S/N 17 was installed on the stage. In S/N 19, the calibration card, P/N 50M65020-3, S/N 17B, was damaged due to the 28 vdc application, and was removed and replaced by S/N 65B. S/N 19 passed retest, and was accepted for further use.

c. FARR A248645 was written during the second issue of the procedure, after multiplexer, P/N 1B62513-529, S/N 19, was reinstalled to replace S/N 17, which was rejected by FARR A248644 during the DDAS automatic checkout. Multiplexer, S/N 19, was again rejected for an intermittent 4.969 vdc output, instead of the required 5.000 ± 0.030 vdc output. The unit was accepted for use. Per WRO S-IVB-3356, the printed circuit cards would be replaced after VCL testing, to correct this problem.

Eighteen revisions were made to the first issue of this procedure, and three additional revisions were made to the second issue.

a. Two revisions added the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the Mandatory End Items list, and deleted it from the Optional End Items list, to meet NASA requirements.

b. One revision changed the applicable test requirements drawing from 1B64686-1 to be 1B64701-1.

c. Eleven revisions made various minor changes in the procedure to conform to the 1B64701-1 test requirements drawing. These changes included: requiring a Model 400H rms voltmeter instead of a Model 403B voltmeter; adding a 130 mfd., 15 vdc, capacitor to the test equipment list; a number of wording, typographical, and test setup figure drawing changes; an added requirement that ACS end item setup procedures be performed in accordance with drawings

4.2.12 (Continued)

1B53599-501 and 1B29278-1; and a requirement that electrical checkout adapter accessory kit, P/N 1B55449-1, be used in the Huntington Beach VCL No. 1, while kit, P/N 1B44042-1, be used at other areas.

d. Four revisions changed the requirements of the 600 kHz VCO bandedge frequencies, and added a requirement for finding the VCO deviation, to conform to NASA documents 50M60067 and 50M66512. The upper bandedge limits were changed from 627.5 to 639.0 kHz, with 633.3 kHz nominal, to be 623.2 to 643.2 kHz, with 633.2 kHz nominal. The lower bandedge limits were changed from 561.0 to 572.5 kHz to be 556.8 to 576.8 kHz. The deviation requirement was set as 70 $\pm$ 10 kHz.

e. Two revisions, applicable only to the second issue, made the necessary changes to delete all parts of the procedure except those involving the replacement CP1-B0 multiplexer, the only item tested by the second issue.

f. One revision, applicable only to the second issue, changed the CP1-B0 multiplexer output tolerance from $\pm$ 0.030 vdc to $\pm$ 0.031 vdc during the flight calibration test, per FARR A248645 and WRO S-IVB-3356, to permit continued use of the multiplexer.

4.2.13 Aft Skirt and Interstage Thermo-Conditioning and Purge System (1B40544 NC)

This manual procedure verified that the airflow characteristics of the aft skirt and interstage thermo-conditioning and purge system were correct, and demonstrated that the system could provide the inert environment required in the aft skirt and interstage area during all test firing and prelaunch operations involving the use of liquid hydrogen. The particular items involved in this test were the aft skirt and interstage thermo-conditioning and purge system installation, P/N 1A67979-515, and the GSE Model DSV-4B-651 aft skirt ventilation system kit, P/N 1B38121-1.

This procedure was started on 7 March 1967, and was completed and accepted on 8 March 1967. Pre-operation setup steps were accomplished to prepare the GSE Model 651 ventilation system for use, to connect it to the stage, and to cover and seal open holes in the stage system airflow areas. The stage system tests were conducted by installing various size orifices in the metering duct of the Model 651 aft skirt ventilation system, opening and closing various purge and ventilation holes on the stage, and measuring the Model 651 metering duct pressure difference and the main manifold pressure while air was blown through the stage system. Purge area charts in the procedure were used to determine the equivalent purge area from the ratio of these pressure measurements.

For the main manifold leakage and fairing purge test, a 1.4 inch diameter orifice, P/N 1B38983-503, was installed; the main manifold orifices in the station 241 frame, the hydraulic system accumulator reservoir shroud ventilation holes, and the thrust structure supply duct were sealed; and the helium bottle shroud supply duct was clamped. From the measured metering duct

4.2.13 (Continued)

orifice pressure difference of 18.0 inches of water, and the main manifold pressure of 5.8 inches of water, it was determined that the leakage and fairing purge area was 2.67 square inches.

For the thrust structure flow test, a 2.1 inch diameter orifice, P/N 1B38983-507, was installed; the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were sealed; the thrust structure supply duct was opened; and the helium bottle shroud supply duct was clamped. From the metering duct pressure difference of 19.1 inches of water, and the main manifold pressure of 4.6 inches of water, it was determined that the gross thrust structure purge area was 6.95 square inches. Subtracting the previously determined leakage and fairing purge area, the net thrust structure purge area was 4.28 square inches, well within the 4.1 $\pm$ 1.0 square inches requirement.

For the helium bottle shroud flow test, a 2.1 inch diameter orifice, P/N 1B38983-507, was installed; the main manifold orifices in the station 241 frame and the thrust structure supply duct were sealed; and the hydraulic system accumulator reservoir shroud ventilation holes and the helium bottle shroud supply duct were opened. From the metering duct pressure difference of 20.7 inches of water, and the main manifold pressure of 3.0 inches of water, it was determined that the gross helium bottle shroud purge area was 8.95 square inches. Subtracting the previously determined leakage and fairing purge area, the net helium bottle shroud purge area was 6.28 square inches, well with the 6.8 $\pm$ 1.2 square inches requirement.

4.2.13 (Continued)

For the main manifold orifice flow test, a 5.2 inch diameter orifice, P/N 1B38983-511, was installed; the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were opened; the thrust structure supply duct was sealed; and the helium bottle shroud supply duct was clamped. From the metering duct pressure difference of 4.3 inches of water, and the main manifold pressure of 1.7 inches of water, the gross main manifold purge area was determined to be 46.25 square inches. Subtracting the previously determined leakage and fairing purge area, the net main manifold purge area was 43.58 square inches, well within the 44.2 ± 6.0 square inches requirement.

Engineering comments noted that there were no parts shortages that affected this test. No problems were encountered during this procedure, and no failure and rejection reports were written. Five revisions were written to the procedure, all to provide that the thrust structure supply duct was to be sealed rather than clamped during the appropriate parts of the test. The FT9031-16-222 hard line flex duct used for the thrust structure supply duct on this stage could not be clamped shut, and to close off the duct it was necessary to temporarily disconnect the flanged end of duct, P/N 1A67978, from the thrust structure and seal the end of the duct. The duct was opened by unsealing the end and reconnecting it to the thrust structure.

4.2.14 Propulsion System Control Console/Stage Compatibility (1B59454 B)

The Model DSV-4B-234 propulsion system control console, P/N 1A65728-1, remotely controlled and monitored the stage propulsion system during automatic and manual checkout operations in the VCL. Prior to using the console, this procedure ensured that the stage-mounted solenoid valves, used to operate the main propulsion system hydraulic valves, responded properly when the control console electrical command switches were operated. The solenoid valves checked by this procedure were located in various actuation and control modules installed in the forward skirt area, the aft skirt area, and the thrust structure area.

The procedure was conducted on 8 March 1967, except for those checks involving the solenoid valves for the LH_2 bi-directional vent valve. After an interim use vent valve was installed, the checks were completed on 13 March 1967. The procedure was accepted on 21 March 1967. For each solenoid valve to be checked, the appropriate control console command switch was operated, and the proper actuation or deactuation of the solenoid valve was audibly verified at the actuation module or control module containing the valve. Verification was also made that the correct indicator lights were illuminated on the Mainstage Propulsion Manual Control Panel of the Model 234 control console. Test Data Table 4.2.14.1 shows the particular solenoid valves checked by this procedure, giving the actuation module or control module containing the solenoid valve, the solenoid valve reference designation, and the solenoid valve function, including the main propulsion system valve controlled by the solenoid valve. All of the solenoid valves checked by this procedure responded properly to the command signals from the propulsion system control console.

4.2.14 (Continued)

Engineering comments noted that several parts were not installed. Seven actuation control modules, P/N 1B66692-1, were missing at locations 403A75A1, 404A9, 404A43, 404A44, 411A2, 411A3, and 411A30. Interim use actuation control modules, P/N 1B65292-501, were installed in place of the above, per SEO's 1B65292-501-005 and -009. The LH_2 bi-directional vent valve 411A29, P/N 1A49988-501, was not installed at the start of the test. An interim use valve, P/N 1A49988-1-002, was installed per SEO 1A49988-1-002 prior to the completion of the test.

No problems were encountered during the test, and no failure and rejection reports were written. One revision was made to the procedure, to add steps to turn on the engine cutoff command before checking solenoid valve 404A43L2, controlling the prevalves, and to turn the command off after checking this valve. This change was required to reflect the latest stage electrical configuration.

4.2.14.1 Test Data Table, Propulsion System Control Console/Stage Compatibility

Solenoid Valve Location	Solenoid Valve Designation	Solenoid Valve Function
-Forward Skirt Area-		
Actuation Module 411A2	411A2L1	Open/Close, LH_2 Tank Vent Valve
	411A2L2	Boost Close, LH_2 Tank Vent Valve
Actuation Module 411A30	411A30L2	Flight Position, LH_2 Tank Bi-Directional Vent Valve
	411A30L1	Ground Pos., LH_2 Tank Bi-Directional Vent Valve

4.2.14.1 (Continued)

Solenoid Valve Location	Solenoid Valve Designation	Solenoid Valve Function
-Aft Skirt Area-		
Actuation Module 404A44	404A44L1	Open/Close, LH_2 Tank Fill & Drain Valve
	404A44L2	Boost Close, LH_2 Tank Fill & Drain Valve
Actuation Module 404A9	404A9L1	Open/Close, LOX Tank Fill & Drain Valve
	404A9L2	Boost Close, LOX Tank Fill & Drain Valve
Actuation Module 404A43	404A43L1	Close/Open, LH_2 & LOX Chilldown Shutoff Valves
	404A43L2	Close/Open, LH_2 & LOX Prevalves
-Thrust Structure Area-		
Actuation Module 403A75A1	403A75A1L1	Open/Close, LOX Tank Vent Valve
	403A75A1L2	Boost Close, LOX Tank Vent Valve
Pneumatic Control Module 403A73A1	403A73A1L2	Close/Open, Control Helium Shutoff Valve
	403A73A1L1	Open/Close, Start Tank Vent Valve
Ambient Helium Fill Module 403A73A5	403A73A5L1	Open/Close, Ambient Helium Sphere Dump Valve
Cold Helium Fill Module 403A74A2	403A74A2L1	Open/Close, Cold Helium Dump Valve
LOX Tank Pressurization Control Mod. 403A74A1	403A74A1L1	Open/Close, Cold Helium Shutoff Valve
	403A74A1L3	Open/Close, Cold Helium Shutoff Valve
Engine Pneumatic Power Package	-	Open/Close, Engine Control Bottle Vent Valve
LH_2 Repressurization Module 403A73A4	403A73A4L1	Open/Close, LH_2 Tank Repressurization Dump Valve
LOX Repressurization Module 403A74A3	403A74A3L1	Open/Close, LOX Tank Repressurization Dump Valve

4.2.15 Propulsion Components Internal Leak Checks (1B59455 NC)

This manual procedure individually measured the reverse seat leakage of the various check valves used in the propulsion system pneumatic pressure lines to restrict pressurization gas flow to one direction only. The thirteen check valves tested by this procedure are noted below.

The procedure was initiated on 8 March 1967, and was completed and accepted on 17 March 1967, after three days of activity. Except for the one valve noted below, each check valve was removed from its installed position in the pressurization system for the reverse seat leakage test. An appropriate pressure gauge assembly was connected to the facility helium supply and to the outlet of each check valve, and the outlet of the check valve was pressurized to the required test pressure. The test pressure was maintained at least one minute before the leakage pressure at the check valve inlet was measured with a flowmeter capable of accurately measuring down to 0.5 scim. After the test, each check valve was reinstalled in its place in the pressurization system.

Five check valves were removed from the pneumatic control system for testing. These valves were from the LOX vent and relief valve purge line, the LH_2 fill and drain valve purge line, the LOX fill and drain valve purge line, the directional control valve purge line, and the ambient helium fill module supply line. Each of these check valves, P/N 1B51361-1, S/N's 226, 247, 256, 259, and 280, was tested at 1500 $\pm$ 100 psig, using a 5000 psi gauge assembly. The allowable leakage was 10 scim. The measured reverse seat leakage of each valve was zero scim.

4.2.15 (Continued)

One check valve, P/N 1A57350-505-002, S/N 227, was an integral part of the ambient helium fill module. This valve was not removed, but was tested at 1500 ± 100 psig by attaching a 5000 psi gauge assembly to the helium fill module outlet. The allowable total leakage at the module inlet and vent was 10 scim. The total reverse leakage was measured as zero scim.

Two check valves, P/N 1B40824-503, S/N's 183 and 185, were removed from the cold helium fill module pressure supply line on the LOX tank pressurization system. Each of these valves was tested at 1500 ± 100 psig, using a 5000 psi gauge assembly. The allowable leakage was 1 scim. The reverse seat leakage was measured as zero scim for each valve.

One check valve, P/N 1B65673-1, was to be removed from the LH_2 tank pressurization control module pressure supply line. However, this valve, S/N 21, was rejected for excess leakage during the LH_2 tank pressurization system leak check, H&CO 1B59456 (reference FARR A228570, paragraph 4.2.16). The replacement check valve, P/N 1B65673-1, S/N 5, was tested prior to installation. The valve was tested at 300 psig, using a 600 psi gauge assembly, and also at 28 ± 3 psig, using a 60 psi gauge assembly. The allowable leakage was 10 scim at each pressure. The measured reverse leakage was zero scim at each pressure.

Four check valves were removed from the LH_2 and LOX tanks repressurization system. One check valve, P/N 1B51361-1, S/N 224, was tested at 1500 ± 100 psig, using a 5000 psi gauge assembly. The allowable leakage was 10 scim. The measured reverse seat leakage for this valve was zero scim. Two check valves, P/N 1B51361-501, S/N's 219 and 279, were tested at 1500 ± 100 psig,

4.2.15 (Continued)

using a 5000 psi gauge assembly, and also at 28 ± 3 psig, using a 60 psi gauge assembly. The allowable leakage was 10 scim at each pressure. The reverse seat leakage for each of these valves was measured as zero scim at each pressure. The remaining check valve, P/N 1B40824-505, was tested at 825 ± 25 psig, using a 5000 psi gauge assembly, and also at 28 ± 3 psig, using a 60 psi gauge assembly. The allowable leakage was 20 scim at each pressure. The removed check valve, S/N 154, was found to have excessive leakage, and was rejected by FARR A228569. A new check valve, P/N 1B40824-505, S/N 156, was tested before installation, with a measured reverse leakage of zero scim.

Engineering comments noted that there were no parts shortages that affected this test. During the test it was found that one check valve in the re-pressurization system was of the wrong configuration. Check valve, P/N 1B51361-1, S/N 230, was installed where a -501 valve was required. The -1 valve was removed, and a proper check valve, P/N 1B51361-501, S/N 279, was installed. As previously noted, one check valve was rejected during another procedure, and was replaced after testing by this procedure. FARR A228569 was written during this procedure when check valve, P/N 1B40824-505, S/N 154, leaked 45 scim with 28 ± 3 psig pressure applied, exceeding the 20 scim allowable limit. A new check valve, P/N 1B40824-505, S/N 156, was installed, and S/N 154 was dispositioned for rework to applicable requirements or replacement.

No revisions were made to the procedure.

4.2.16 Fuel Tank Pressurization System Leak Check (1B59456 A)

This procedure manually leak checked the LH_2 tank pressurization system prior to its use during automatic procedures. The pressurization system consisted of the ground pressurization line from the aft umbilical, and the flight pressurization line from the J2 engine, both to the pressurization control module; the pressurization line from the control module to the LH_2 tank forward dome; and the tank ullage pressure sensing lines leading to pressure switches and transducers. The flight pressurization line was checked during the J2 engine system leak check, and not as part of this procedure. Leaks were detected by the use of a USON leak detector or leak detection bubble fluid.

Initiated on 9 March 1967, the procedure was completed on 10 March 1967, and was accepted on 21 March 1967. The facilities pneumatic lines for the LH_2 tank pre-pressurization supply and the LH_2 pressure switch checkout supply were connected to the stage aft umbilical plate. The LH_2 tank pressurization line was disconnected at the interface of pipe assemblies, P/N 1B43397-1 and 1B63355-1. Pipe assembly, P/N 1B63355-1, was capped to prevent contamination, and a test adapter blanking flange, P/N 59021-1-150S-4, with a hand valve, P/N 1A66801-1, was installed on pipe assembly, P/N 1B43397-1. The repressurization supply line, P/N 1B51444-005-3, and the pilot bleed line, P/N 1B58858-1, were disconnected at their interfaces with the LH_2 tank pressurization line. The ports on the pressurization line were capped, and the disconnected lines were plugged, to prevent contamination. The GSE electrical and pneumatic consoles were set up for the test, and the Model 321 console was pressurized with helium as follows: Stage 1 was loaded to about 1500 psia; stage 4 was loaded to about 500 psia; stages 5

4.2.16 (Continued)

and 6 were loaded to about 100 psia each; and stage 7 was loaded to between 40 and 45 psia.

The LH_2 pre-pressurization supply valve was momentarily opened while it was audibly verified that there was no gross leakage. The Model 321 console stage 5 line pressure was increased to 300 $\pm$ 20 psia, and the LH_2 pre-pressurization supply valve was reopened. The LH_2 tank ground pressurization line was leak checked from the aft umbilical disconnect to the control module. One area of leakage was found and corrected, as noted by FARR A228570. The pressure sensing line between the control module and transducer D104, the cap assembly connection on the control module, and the LH_2 tank pressurization line from the control module to the blanking flange, were all leak checked with no discrepancies.

The pre-pressure supply valve was closed and pressure in the LH_2 pressurization supply line was vented using the hand valve on the blanking flange. Temperature transducer C231 was removed from pipe assembly, P/N 1B64384-1, and flange, P/N 1B04371-1, was installed. The LH_2 pre-pressure supply valve was opened, and the reverse seat leakage of the LH_2 tank pressurization module check valve was measured with a flowmeter. This leakage was measured as zero scim, while the maximum allowable leakage was 10 scim. The stage 5 line pressure was reduced to 15 $\pm$ 5 psig and the check valve reverse seat leakage was again measured as zero scim, with a maximum allowable leakage of 50 scim.

The LH_2 system checkout supply valve was opened, and the LH_2 tank pressure switch checkout supply lines were leak checked from the aft umbilical dis-

4.2.16 (Continued)

connect to the two LH_2 tank pressure switches. No leakage was noted during this check. This concluded the leak checks, and the LH_2 pre-pressure and checkout supply valves were both closed, as was the helium console supply valve. The Model 321 console was vented, and the pressure in the LH_2 pressurization supply line was relieved by opening the hand valve in the blanking flange. Flange, P/N 1B04371-1, was removed from pipe assembly, P/N 1B64384-1, and temperature transducer C231 was reinstalled. The blanking flange and hand valve were left installed for use during subsequent leak checks.

Engineering comments noted that there were no parts shortages affecting this test. The only leakage found during this test was covered by the following failure and rejection reports:

a. FARR A228570 noted heavy leakage at the LH_2 pressure check valve, P/N 1B65673-1, S/N 21, and at the mating B-nut on LH_2 pipe assembly, P/N 1B64112-1, at thrust structure stringer 6. Both leaks were due to scored flare surfaces. The check valve was removed and dispositioned by FARR A228572. A new valve, P/N 1B65673-1, S/N 5, was checked by H&CO 1B59455 (reference paragraph 4.2.15), and installed. Rework of the pipe assembly by FARR A228573 did not correct the leak, and a new pipe assembly, P/N 1B64112-1, was installed. The leakage was stopped by the installation of these replacement parts.

b. FARR A228572 dispositioned the pressure check valve, P/N 1B65673-1 S/N 21, for the above leakage. The damaged flare was reworked to an acceptable condition or replaced.

c. FARR A228573 dispositioned the pipe assembly, P/N 1B64112-1, for the above leakage. The damaged flare surface was polished to an acceptable condition, but the leakage continued. The pipe assembly was found to be out-of-round, and was scrapped.

Four revisions were made to the procedure for the following:

a. Three revisions added omitted test steps to plug and cap open lines to prevent contamination, to remove and later replace temperature transducer C231, and to perform the reverse seat leakage tests on the check valve.

4.2.16 (Continued)

b. One revision changed all references to pipe assembly, P/N 1B58859-1, to reference pipe assembly, P/N 1B51444-005-3, for this stage only, as the pipe assembly had been re-developed per SEO 1B51444-005.

4.2.17 Power Distribution System (1B66562 A)

The automatic checkout of the stage power distribution system verified the capability of the GSE to control power switching to and within the stage, and determined that static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized as required, and that bi-level talkback indications were received at the GSE. Static loading of the various stage systems or assemblies was determined by measuring the GSE supply current before and after turn-on of the system. All electrical components on the stage were involved in this test, including the point level sensors, the propellant utilization system, the auxiliary propulsion system, the J-2 engine ignition bus, the stage telemetry system, the stage power buses, the LOX and LH_2 chilldown inverters, and the external to internal power transfer system.

The procedure was conducted on two separate days, 10 March 1967 and 13 March 1967, and was accepted on 27 March 1967. Two test runs were attempted on 10 March 1967. The first test run was terminated because range safety decoder 411A99A1, P/N 50M10698, S/N 135, did not turn on properly. The unit was rejected by FARR A228571 and replaced. The second test run was terminated when the GSE forward bus 1 power supply tripped but the stage forward bus 1 remained on. Wire harness 404A3W1 was found to be improperly wired, giving an incorrect talkback signal. The wire harness was reworked by FARR A228574. By 13 March 1967, the reworked wire harness was reinstalled, and the third test run was satisfactorily accomplished. The values measured during this last test run are shown in Test Data Table 4.2.17.1.

After the stage power setup, H&CO 1B66560, was accomplished, and initial conditions were established, a point level sensor test was conducted. Each

4.2.17 (Continued)

of the four LH_2 tank point level sensors, and four LOX tank point level sensors, were checked and found to respond properly within 300 milliseconds when individual simulated wet condition ON and OFF commands were given. The engine control bus power was turned on, and it was verified that the emergency detection system 2 engine cutoff signal would turn the engine control bus power off and prevent it from being turned back on. The engine cutoff signal was turned off, the engine control bus power was again turned on, and the bus voltage was measured. The component test power was verified to be within the proper limits of 28 $\pm$ 2 vdc when turned on, and 0 $\pm$ 1 vdc when turned off. A series of checks satisfactorily verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition OFF commands, resulted in the required engine cutoff signal. For the dry condition of LOX tank point level sensors 1 and 2, the engine cutoff LOX depletion timer value was measured to determine the cutoff signal delay time.

The PU inverter and electrical power was momentarily turned on while the current was measured. The APS bus power was turned on, verified to be on, and turned off. The engine ignition bus power was momentarily turned on while the bus voltage was measured. The PCM RF assembly power was turned on and the current was measured. The telemetry RF silence command was turned on, the PCM RF assembly was verified as being off, and the current change due to the telemetry RF silence command was measured. The telemetry RF silence command was turned off, the PCM RF assembly was verified as again being on, and was then turned off. The environmental control group was turned on, verified to be on, and turned off. The aft bus 2 power was turned on and the bus voltage was measured.

4.2.17 (Continued)

For the chilldown inverter no load tests, the LH_2 and LOX chilldown inverters were individually turned on while the inverter operating frequencies and output voltages were measured. The chilldown pump simulators were then connected to receptacle 404A74A1J3 on the LOX chilldown inverter, and to receptacle 404A74A2J3 on the LH_2 chilldown inverter, for the chilldown inverter load tests. The LH_2 and LOX chilldown inverters were again individually turned on while the inverter input currents, operating frequencies and output voltages were measured.

The rate gyro was turned on, and the gyro heater and sensor power voltages were manually measured. The gyro was then turned off and both voltages were manually verified to be 0.0 $\pm$ 0.1 vdc. The battery simulators were turned on for forward bus 1 and bus 2, and aft bus 1 and bus 2, and the battery simulator voltages were measured. The voltages of the electrical support equipment load banks were measured at buses 4D20, 4D40, 4D30, and 4D10. Forward bus 1 and bus 2, and aft bus 1, were transferred to internal, the external power supplies were turned off, and the bus internal voltages were measured. The aft bus 1 external power supply was turned back on, aft bus 1 was transferred to external, and the bus voltage was measured. The aft bus 1 battery simulator was turned off, and the simulator voltage was measured. Aft bus 2 was transferred to internal, the external power supply was turned off, and the bus internal voltage was measured. The external power supply was turned back on, aft bus 2 was transferred to external, and the bus external voltage was measured. The aft bus 2 battery simulator was turned off, and the simulator voltage was measured. The forward bus 1 and bus 2 external power supplies were turned on, the buses were transferred to

4.2.17 (Continued)

external, and the bus external voltages were measured. The forward bus 1 and bus 2 battery simulators were turned off, and the simulator voltages were measured. The aft bus 2 power supply was turned off, and the bus voltage was measured.

A number of automatic checks were conducted that satisfactorily verified the proper operation of the switch selector register, and the range safety receiver and EBW firing unit internal/external transfer. No voltage or current measurements were made during these final checks. The computer printout indicated that the running times accumulated during the third test run were 0.617 seconds for the LH_2 chilldown pump simulator, 0.643 seconds for the LOX chilldown pump simulator, and 0.068 seconds for the range safety receiver 1.

Engineering comments noted several parts shortages during this test. The continuous vent module 411A32, P/N 1B67193-501, was not installed. The LH_2 vent and relief valve 411A1, P/N 1A48257-511, and the directional control valve 411A29, P/N 1A49988-1, were not installed at the start of the procedure, but were installed prior to the third test run. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed per SEO 1A49590-513-018, in place of LOX vent and relief valve 424A1, P/N 1A48312-505.

As noted, two failure and rejection reports were written during the first two test runs.

a. FARR A228571 noted that range safety decoder 411A99A1, P/N 50M10698, S/N 135, had pin 38 of receptacle J1 bent over. The decoder was removed and returned to government stores for rework. A new unit, S/N 92, was installed.

4.2.17 (Continued)

b. FARR A228574 noted that wire harness 404A3W1, P/N 1B34883-1, S/N 2, had a wire, P222H20, incorrectly installed between pin H of plug P22, and pin k of plug P18. The wire was reterminated per drawing requirements, and the wire harness was checked and accepted for use.

Eight revisions were made to the procedure for the following:

a. One revision added the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the Mandatory End Items list, as it was a mandatory use item.

b. One revision added the MRC 503 command receiver, P/N 50M10697, and the range safety control decoder, P/N 50M10698, to the Running Time/Cycle Record paragraph, as these were time significant items.

c. One revision changed two malfunction printouts to correct procedure errors.

d. One revision added the steps to turn the rate gyro on and off, and to manually measure the heater and sensor power voltages for both conditions. One other revision required the use of a Simpson 260 voltmeter to make these measurements, rather than a Fluke voltmeter as originally specified.

e. One revision changed two malfunction printouts to read "chilldown inverter load test", rather than "no load test", as the chilldown pump simulators were connected to the inverters at the time these printouts would have been used.

f. One revision increased the delay between the time the chilldown inverters were turned on, and the time the frequencies were measured, from 2 seconds to 5 seconds, as more time was needed for the frequencies to become stable.

g. One revision deleted the LH_2 continuous vent valve module, P/N 1B67193-501, from the initial conditions scan because of the malfunction typeouts that resulted from this unit not being installed.

4.2.17.1 Test Data Table, Power Distribution System

Function	Measured Value	Limits
Engine Control Bus Voltage (vdc)	27.66	28.0 ± 2.0
Engine Cutoff LOX Depletion Timer (seconds)	0.558	0.56 ± 0.025
PU Inverter and Electrical Power Current (amps)	3.4	5.0 max.
Engine Ignition Bus Voltage (vdc)	27.75	28.0 ± 2.0
PCM RF Assembly Current (amps)	4.5	4.5 ± 3.0
Telemetry RF Silence Current Change (amps)	4.8	3.0 min.
Aft Bus 2 Voltage (vdc)	56.32	56.0 ± 4.0
-Chilldown Inverter No Load Tests-		
LH_2 Inverter Frequency (Hz)	399.555	400.0 ± 4.0
LH_2 Inverter Phase AB Voltage (vac)	54.5	55.0 ± 5.0
LH_2 Inverter Phase AC Voltage (vac)	54.7	55.0 ± 5.0
LOX Inverter Frequency (Hz)	400.00	400.0 ± 4.0
LOX Inverter Phase AB Voltage (vac)	54.3	55.0 ± 5.0
LOX Inverter Phase AC Voltage (vac)	54.3	55.0 ± 5.0
-Chilldown Inverter Load Tests-		
LH_2 Inverter Current (amps)	20.80	22.0 ± 5.0
LH_2 Inverter Frequency (Hz)	400.09	400.0 ± 4.0
LH_2 Inverter Phase AB Voltage (vac)	53.4	55.0 ± 5.0
LH_2 Inverter Phase AC Voltage (vac)	53.4	55.0 ± 5.0
LOX Inverter Current (amps)	21.00	22.0 ± 5.0
LOX Inverter Frequency (Hz)	400.09	400.0 ± 4.0
LOX Inverter Phase AB Voltage (vac)	53.1	55.0 ± 5.0
LOX Inverter Phase AC Voltage (vac)	53.1	55.0 ± 5.0
Rate Gyro Heater Voltage (vdc)	28.4	28.0 ± 2.0
Rate Gyro Sensor Voltage (vdc)	28.3	28.0 ± 2.0
Forward Bus 1 Battery Simulator Voltage (vdc)	28.12	28.0 ± 2.0
Forward Bus 2 Battery Simulator Voltage (vdc)	28.00	28.0 ± 2.0
Aft Bus 1 Battery Simulator Voltage (vdc)	27.92	28.0 ± 2.0
Aft Bus 2 Battery Simulator Voltage (vdc)	56.24	56.0 ± 4.0
ESE Load Bank Bus 4D20 Voltage (vdc)	0.04	0.0 ± 1.0
ESE Load Bank Bus 4D40 Voltage (vdc)	0.00	0.0 ± 1.0
ESE Load Bank Bus 4D30 Voltage (vdc)	0.04	0.0 ± 1.0
ESE Load Bank Bus 4D10 Voltage (vdc)	0.00	0.0 ± 1.0
Forward Bus 1 Internal Voltage (vdc)	28.12	28.0 ± 2.0
Forward Bus 2 Internal Voltage (vdc)	28.00	28.0 ± 2.0
Aft Bus 1 Internal Voltage (vdc)	28.00	28.0 ± 2.0
Aft Bus 1 External Voltage (vdc)	27.92	28.0 ± 2.0
Aft Bus 1 Battery Simulator Voltage (vdc)	0.08	0.0 ± 1.0
Aft Bus 2 Internal Voltage (vdc)	56.32	56.0 ± 4.0
Aft Bus 2 External Voltage (vdc)	56.32	56.0 ± 4.0
Aft Bus 2 Battery Simulator Voltage (vdc)	0.00	0.0 ± 1.0
Forward Bus 1 External Voltage (vdc)	28.00	28.0 ± 2.0
Forward Bus 1 Battery Simulator Voltage (vdc)	0.04	0.0 ± 1.0
Forward Bus 2 External Voltage (vdc)	28.00	28.0 ± 2.0
Forward Bus 2 Battery Simulator Voltage (vdc)	0.08	0.0 ± 1.0
Aft Bus 2 Voltage (vdc)	0.00	0.0 ± 1.0

4.2.18 Digital Data Acquisition System (1B66564 A)

The digital data acquisition system (DDAS) test verified the operation of all data channels on the stage, except certain data channels that were tested during specific system tests. The GSE D924A computer verified that the output of each channel tested was within the specified tolerances. All channels having calibration capability were checked under a RACS high mode or low mode calibration command, as well as under ambient conditions. Proper operation was verified for the DDAS signal conditioning equipment and associated amplifiers, the remote automatic calibration system (RACS) and the associated command calibration channel decoder assemblies, and the telemetry antenna system. The proper operation of the following particular items was also verified:

Part Name	Reference Location	P/N	S/N
PCM/DDAS Assembly	411A97A200	1A74049-511	14
CP1-B0 Time Division Multiplexer	404A61A200	1B62513-529	19
DP1-B0 Time Division Multiplexer	404A61A201	1B62513-513	3
Remote Digital Submultiplexer (RDSM)	404A60A200	1B52894-1	9
Remote Analog Submultiplexer (RASM)	404A60A201	1B54062-503	21
PCM RF Assembly	411A64A200	1B52721-509	33

This automatic procedure was initiated on 10 March 1967, and was completed by the sixth test run on 5 April 1967, after five days of activity. The first five test runs were not acceptable because of programming errors and out-of-tolerance conditions. These problems were corrected by program changes and the replacement of a transducer kit, a transducer, and the CP1-B0 multiplexer (reference FARR's A228575, A248630, and A248644). One transducer failed during the sixth test run (reference FARR A248646), and was replaced and individually checked on 6 April 1967. The procedure was accepted on 11 April 1967.

4.2.18 (Continued)

The PCM RF test was conducted first. The forward and reflected RF output powers of the PCM/DDAS assembly were measured through both the BO (CP1) and AO (DP1) multiplexer telemetry outputs, and the voltage standing wave ratio (VSWR) was determined. The same measurements were also made through the ground monitor outputs for both multiplexers. The BO multiplexer telemetry readings were: forward power, 25.103 watts; reflected power, 0.562 watts; VSWR, 1.352. The AO multiplexer telemetry readings were: forward power, 25.697 watts; reflected power, 0.578 watts; VSWR, 1.353. The BO multiplexer ground monitor readings were: forward power, 25.311 watts; reflected power, 0.278 watts; VSWR, 1.233. The AO multiplexer ground monitor readings were: forward power, 25.667 watts; reflected power, 0.287 watts; VSWR, 1.236. All of these readings met the requirements of forward power, 15.0 watts minimum; reflected power, 2.0 watts maximum; and VSWR, 3.0 maximum. High and low RACS tests were conducted on the measurement channels for the aft 5 volt excitation modules, while both the ground monitor and telemetry outputs were measured. The output values were all within the required tolerance of the expected values.

The CP1-BO multiplexer was tested next, except for special channels. This test made measurements of the high and low RACS voltages of each channel having calibration capability, and measurements of the ambient output in psia, on, off, vdc, amps, or degrees, as appropriate for each channel tested. Reference channels were tested for zero or full scale indications, as appropriate for the particular channel. Each output was compared to the appropriate expected value to verify that it was within the required tolerance limits. The output values for each of the CP1-BO multiplexer

4.2.18 (Continued)

channels tested were with the required limits except for one value. The high RACS test of channel CP1-B0-14-05, measurement D88, was 4.122 vdc, outside the expected value of 4.000 ± 0.100 vdc. This was corrected by the subsequent replacement of the transducer for measurement D88 (Reference FARR A248646).

The DP1-B0 multiplexer was tested, except for special channels, in the same way as the CP1-B0 multiplexer. The output values for each of the DP1-B0 multiplexer channels tested were within the required limits except for the following three values. Channel DP1-B0-06-05, measurement D9, had a low RACS value of 0.948 vdc, outside the expected value of 1.050 ± 0.100 vdc. This was acceptable, as a revision corrected the expected value to 0.960 ± 0.100 vdc, to agree with the Rocketdyne data for the D9 transducer. Channel DP1-B0-07-01, measurement D209, had an ambient value of 14.795 psig, outside the expected value of 0.000 ± 1.200 psig. This was acceptable, as the auxiliary hydraulic pump motor gas lines had been previously pressurized, and gas trapped in the system raised the expected ambient pressure to 15.0 ± 1.2 psig. Channel DP1-B0-14-05, measurement D88, had a high RACS value of 4.128 vdc, outside the expected value of 4.000 ± 0.100 vdc. This was corrected by the previously noted replacement of the transducer.

The special channel tests were conducted next. The GSE Model 296 telemetry signal distribution unit was manually adjusted to provide a calibration signal of 400.00 ± 8.00 Hz at 3.0 ± 0.1 vrms, as measured by an rms voltmeter and a frequency counter connected to the appropriate acoustical output test jacks on the telemetry calibrator panel. The frequency was measured as 402.50 Hz, giving a voltage equivalence of 3.125 vdc. Those special channels

4.2.18 (Continued)

measuring 400 Hz signals for the static inverter-converter frequency, the LH_2 and LOX chilldown inverter frequencies, and the LOX and LH_2 circulation pump flow rates, were checked by the appropriate high or low RACS test, and by the 400 Hz calibration signal. All of these special channels were within the required tolerance of the expected values except one. Channel DP1-B0-04-03, measurement M12, had a high RACS value of 3.061 vdc, outside the expected value of 3.125 $\pm$ 0.050 vdc. The expected value was corrected to 3.125 $\pm$ 0.075 vdc, and the value was accepted. A calibration signal of 100 $\pm$ 2 Hz at 1.77 $\pm$ 0.18 vrms was similarly set and used to check those special channels measuring LOX and LH_2 flowmeter outputs, and a calibration signal of 1500 $\pm$ 30 Hz at 1.77 $\pm$ 0.18 vrms was set and used to check those special channels measuring the LOX and LH_2 pump speeds. All of these special channels were within the required tolerance of the expected values.

An APS simulator multiplexer test was conducted to check those special channels on both multiplexers that measured APS functions. Measurements were made of the high and low RACS voltages of each of these channels having calibration capability, and the ambient outputs were measured in degrees or psia, as appropriate for the channel tested. All of these special channels were within the required tolerance of the expected values.

The final DDAS test was the umbilical measurement test. The umbilical instrumentation signals were measured for the common bulkhead pressure, the common bulkhead 20 percent and 80 percent calibration voltages, the LH_2 ullage pressure, the LH_2 ullage 20 percent and 80 percent calibration voltages, the LOX ullage pressure, the LH_2 emergency detection system pressure transducers 1 and 2, and the LOX emergency detection system pressure trans-

4.2.18 (Continued)

ducers 1 and 2. All of these measurements were within the required tolerance limits of the expected values.

Engineering comments noted that three parts were not installed during this test. An interim use continuous vent module, P/N 1B51753-501-007, was installed at location 411A32 per SEO 1B67193-004, in place of the flight use continuous vent module, P/N 1B67193-501. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed at location 424A1 per SEO 1A49590-018, in place of the flight use valve, P/N 1A48312-505. The directional control valve 411A29, P/N 1A49988-1, was not installed, and no interim use part was installed. These items were scanned during the initial conditions check, but did not otherwise affect the DDAS test.

Three engine transducers, P/N NA5-27323T3, for measurements C1, C2, and C215, were listed in the engine log book as non-flight items. These transducers and their circuits checked out satisfactorily during the test.

As noted previously, the main problems encountered during this test were with program errors and defective parts. The following failure and rejection reports were written:

a. FARR A228575 noted that the amplifier of transducer kit 403MT751, P/N 1B53573-507, S/N 507-7, had failed. The high RACS, low RACS, and ambient values were all out-of-tolerance. The transducer kit was removed and returned to the vendor, and transducer kit, P/N 1B53573-507, S/N 507-9, was installed at 403MT751.

b. FARR A248630 noted the failure of Rocketdyne transducer 3MTP5, P/N NA5-27412T15T, S/N 6148A, on the J2 engine, P/N 103826, S/N J2094. The high RACS, low RACS, and ambient values were all out-of-tolerance. The transducer was removed and replaced by an operating unit.

4.2.18 (Continued)

c. FARR A248644 was written for a malfunction of the CP1-B0 multiplexer 404A61A200, P/N 1B62513-529, S/N 17. Channel CP1-B0-05-02 was out-of-tolerance. Multiplexer, S/N 17, was removed and replaced by S/N 19. Retest of S/N 17 did not confirm the defect, and the unit was acceptable for further use.

d. FARR A248646 noted the failure of pressure transducer 403MT664, P/N 1B39293-1, S/N 28, for measurement D88. As noted previously, the high RACS values for channels CP1-B0-14-05, and DP1-B0-14-05, were out-of-tolerance during the final test run. Transducer, S/N 28, was removed, and S/N 36 was installed and satisfactorily tested.

A total of forty-three revisions were made to the procedure, with one of these voided, and one other deleted. The remaining revisions covered the following:

a. Two revisions added drawings 1B66561-1, Stage Power Turnoff, and 1B66555-1, Installation, Vehicle Simulators, Manual, to the Applicable Documents list.

b. Three revisions changed manual setup paragraph numbers to agree with the program and the test requirements drawing.

c. One revision deleted verification of the aft 2 power supply input, as there was no requirement for this power to be on.

d. One revision added a manual step to install the vehicle simulators per drawing 1B66555-1, to agree with test requirements drawing 1B64687.

e. Nine revisions changed the tolerance limits for measurements C50, D41, D43, M24, M25, M68, and M12, to correct wrong tolerances; for measurement D9, to agree with Rocketdyne vendor data; for measurement D209, to account for trapped gas pressure; and for measurements D1, M21, and M22, to correct digital data tape errors.

f. Two revisions added checks for measurements D87 and C205, as these transducers were installed.

g. Eighteen revisions made program changes and corrections to permit proper operation of the test procedure.

h. One revision deleted measurements of the aft batteries 28 and 56 vdc, as the simulators were not modified to provide these voltages.

4.2.18 (Continued)

i. One revision added a requirement that the DDAS printout be compared to the test requirements drawing to verify tne responses. This was required by DAC letter A3-860-KKB0-9.35.9-L-3676, dated 9 December 1966.

j. One revision deleted a previous revision that had been written in error.

k. One revision deleted the results of the test on measurement D88 during the last test run, as the transducer was to be replaced and manually retested.

l. One revision deleted the RACS test on channel DP1-B0-05-07, measurement N55, because of a digital data tape error. The high and low RACS test of the measurement on the CP1-B0 multiplexer was satisfactory.

4.2.19 Cold Helium System Leak Check (1B59458 A)

This manual leak check and functional check verified the integrity of the cold helium system, and demonstrated the capability of the system to supply and regulate the helium gas used to pressurize the LOX tank. The particular items involved in this test included the cold helium spheres, P/N 1A48858-1, S/N's 1063, 1069, 1093, 1112, 1113, 1120, 1125, 1135, and 1140; the plenum sphere, P/N 1A49991-1, S/N 27; the cold helium fill module, P/N 1B57781-501, S/N 4; the LOX tank pressurization control module, P/N 1B42290-503, S/N 20; the LOX chilldown pump purge pressure switch S4, P/N 1B52624-515, S/N 27; the LOX pre-pressurization flight control pressure switch S8, P/N 1B52624-515, S/N 29; and the associated plumbing and manifold assemblies.

Initiated on 10 March 1967, the procedure was completed on 16 March 1967 after four days of activity, and was accepted on 4 April 1967. In general, the leak checks were conducted by pressurizing the system with helium gas and using a helium leak detector to locate leakage. Gross leaks were detected audibly by listening for escaping gas, and LOX compatible leak test bubble solution was used when required.

The GSE setup was accomplished, and all necessary access plates were removed from the main and auxiliary tunnels, the aft skirt, and the thrust structure, to provide access to the cold helium system components. The LOX tank was isolated from the cold helium system by disconnecting and capping pipe assembly, P/N 1B52485-1, and connecting a bolted flange, P/N MFC60123-125A-4, a union, P/N AN815-C4, and a hand valve, P/N 1A66801-1, to pipe assembly, P/N 1B55285-1.

4.2.19 (Continued)

The LOX tank pressure switch checkout line was pressurized to 50 ± 5 psia, and leak checked from the aft umbilical disconnect to the LOX chilldown pump purge pressure switch, and to the LOX pre-pressurization flight control pressure switch. No leakage was found during this check.

The hand valve on pipe assembly, P/N 1B55285-1, was closed, and the cold helium shutoff valves were opened. The LOX tank pre-pressurization supply valve was opened, and the cold helium spheres were pressurized to 50 psig. The system was audibly checked for major leaks upstream or downstream of the pressurization control module. One leak was found and corrected as noted below.

The cold helium dump valve was checked for proper operation by momentarily opening the dump valve and audibly verifying that gas flowed through the dump port. The cold helium shutoff valves were then closed, and the system downstream of the pressurization control module was vented to ambient pressure through the hand valve on the LOX tank pressurization line. The cold helium spheres were pressurized to 500 psia, while the cold helium regulated discharge pressure was monitored to verify that the discharge pressure did not increase as the spheres were pressurized. The hand valve on the LOX tank pressurization line was opened, and the cold helium spheres pressure was increased to 750 psia. This pressure was maintained for 3 minutes for a sphere integrity test. No problems were encountered during this part of the test.

Following the integrity test, the spheres were vented to 700 psia by opening the cold helium dump valve. Leak checks were then conducted on the

4.2.19 (Continued)

pressurization supply line from the aft umbilical disconnect to the fill module inlet; at the control module inlet connections; from the connection between the fill module and pipe assembly, P/N 1B62809-1, to the end of the spheres manifold assembly, P/N 1A68668-505; and at the spheres-to-manifold leak check ports. Five leaks were found and corrected during these checks, as noted below.

The cold helium spheres were vented to 500 psig by opening the cold helium dump valve. During the venting period, all connections of the cold helium dump valve vent system were verified to have no audible leakage. The cold helium fill module dump and relief valve seat leakage was measured through the overboard vent, and the seat leakage of the LOX tank pressurization control module shutoff valves was measured through the hand valve on pipe assembly, P/N 1B55285-1. Both of these measurements were verified to be less than the limits of 12.5 scim each.

The cold helium spheres were vented to 250 psig, the hand valve on pipe assembly, P/N 1B55285-1, was closed, and the cold helium shutoff valves were opened. Leak checks were then conducted from the pressurization control module to the plenum sphere; from the plenum sphere outlet to adapter, P/N 1B52432-501; from the adapter to transducer D105 and thermistor C230; from the adapter to the pressure switch; and from the adapter to the heat exchanger by-pass line, P/N 1B64136-1. Leak checks were also conducted on the heat exchanger inlet line from the adapter to the J-2 engine heat exchanger; on the heat exchanger return line from the heat exchanger to the pressurization control module inlet; and on the pressurization control module outlet line from the control valve to the blanking flange installed on pipe

4.2.19 (Continued)

assembly, P/N 1B55285-1. Two leaks were found and corrected during these checks, as noted below. This completed the cold helium system leak check. The system was vented to ambient, the blanking flange and hand valve were removed from pipe assembly, P/N 1B55285-1, the cap was removed from pipe assembly, P/N 1B52485-1, and the two pipe assemblies were reconnected.

As noted, the following eight leaks were found and corrected during this procedure.

a. Manifold assembly, P/N 1A68668-503, leaked heavily at the connection to helium sphere 1 at location 405MT605 in the main tunnel. The conoseal was mislocated and extended 1/2 inch out from the side of the mating surfaces. The conoseal was replaced, and the connection was retested and accepted.

b. Pipe assembly, P/N 1B52413-1, leaked at the downstream B-nut at thrust structure stringer 8. FARR A248628 reworked the pipe assembly, and the connection was retested and accepted.

c. Pipe assembly, P/N 1B67329-1, to cold helium sphere 8, leaked at the B-nut connection to the transducer for measurement D16, in the auxiliary tunnel area. The B-nut was retorqued to an acceptable condition.

d. Pipe assembly, P/N 1B52441-1, at the entrance to the forward skirt, leaked at the downstream B-nut in the auxiliary tunnel, and also at the downstream B-nut in the main tunnel. Both of these B-nuts were retorqued to an acceptable condition.

e. Manifold assembly, P/N 1B68668-505, to cold helium sphere 5, leaked at the upstream B-nut in the auxiliary tunnel. This B-nut was also retorqued to an acceptable condition.

f. Pipe assembly, P/N 1B64137-1, leaked at the upstream B-nut at thrust structure stringer 8 3/4. FARR's A248627 and A248629 reworked this pipe assembly, and the mating pipe assembly, P/N 1B58807-1, to correct this problem.

g. Pipe assembly, P/N 1B64131-1, leaked at the upstream B-nut at thrust structure stringer 10. The B-nut was retorqued to an acceptable condition.

4.2.19 (Continued)

Engineering comments noted that there were no parts shortages affecting this test. No revisions were made to the procedure. As noted, three failure and rejection reports were written during this procedure, for the following:

a. FARR A248627 noted that the flare seat area was damaged on the upstream end of pipe assembly, P/N 1B64137-1. The flare was polished per DPS 10001, cleaned, and accepted for use.

b. FARR A248628 noted that the flare seat area was damaged on the upstream end of pipe assembly, P/N 1B52413-1. The flare was polished to an acceptable condition per DPS 10001.

c. FARR A248629 noted that the fitting seat surface was damaged on the downstream end of pipe assembly, P/N 1B58807-1. The surface was polished per DPS 10002, cleaned per DPS 43000, and accepted for use.

4.2.20 Pneumatic Control System Leak Check (1B59457 A)

This manual procedure leak checked the components of the pneumatic control system to verify that there was no leakage in excess of design specifications. The pneumatic control system provided gaseous helium for the stage purge systems and pneumatically operated valves, and included a helium sphere, a helium fill module, a pneumatic control module, a plenum chamber, seven actuator control modules, an engine pump purge module, a LOX chilldown pump purge module, the various pneumatic valves, and the associated plumbing and electrical circuitry.

Initiated on 11 March 1967, the procedure was completed on 29 March 1967 after five days of activity, and was accepted on 4 April 1967. In general, the test was accomplished by pressurizing the pneumatic control system with gaseous helium, and using a USON leak detector as the primary method of detecting leakage. Leak test bubble fluid was used when required as a secondary detection method. The APS bottle supply lines and six purge lines were capped off at one end during this test, to allow pressurization.

The APS bottle supply lines were pressurized to 1500 $\pm$ 50 psia and leak checked. The pneumatic control sphere was subjected to a three minute integrity test at 750, +0, -25, psia, and then vented to 700 $\pm$ 25 psia to provide pressure for subsequent leak checks. Leak checks were conducted on all pneumatic control supply lines, on all purge lines, and on the following components of the system: the pneumatic control module; the engine pump purge control module; the LOX chilldown pump and the pump purge control module; the LOX and LH_2 prevalves and chilldown shutoff valves, and the actuation control module for these valves; the LOX and LH_2 vent and relief valves and their actuation control modules; the LOX and LH_2 fill and drain

4.2.20 (Continued)

valves and their actuation control modules; the directional control valve and its actuation control module; the LH_2 continuous vent valve and its actuation control module; and the system pressure switches and transducers. Six instances of leakage were found and corrected as noted below.

In addition to the leak checks, seal leakage rates were measured at the regulator discharge valve monitor port, at all actuation control module vent ports, at the LOX chilldown pump, at the LOX prevalve piston actuator, and at the directional control valve vent port and locking piston. These leakage rates were all zero scim or zero sccm, except for the LOX fill and drain valve actuation control module. This leakage was measured as 20 sccm, well within the maximum allowable limit of 100 sccm for this unit.

After the six noted leaks were corrected, a system pressure decay test showed that the pneumatic control sphere pressure dropped from 742 psia to 735 psia over thirty minutes with the pneumatic valves deactuated, and dropped from 727 psia to 724 psia over thirty minutes with the pneumatic valves all actuated. These pressure decays were acceptable.

The following leaks were found and corrected during this procedure:

a. At thrust structure stringer 10 3/4, pipe assembly, P/N 1B52541-1, leaked at the connection to a transducer. The B-nut was retorqued and accepted.

b. At thrust structure stringer 5 1/4, pipe assembly, P/N 1B65189-1, leaked at the tee connection to pipe assembly, P/N 1B64148-1. The connection was retorqued and accepted.

c. At thrust structure stringer 6, pipe assembly, P/N 1B64882-1, leaked at the weld upstream of the tee. FARR A248626 was written rejecting the pipe assembly, and it was replaced, correcting the leak. The leaking pipe assembly was rewelded to an acceptable condition.

4.2.20 (Continued)

d. At thrust structure stringer 7, pipe assembly, P/N 1B67224-1, leaked at the seal in the connection to the plenum on panel A73. The defective seal was replaced, correcting the leak.

e. The LOX chilldown pump purge module, P/N 1A58347-505, leaked at the connection with pipe assembly, P/N 1B64138-1, on panel A75A2. It was found that an extra orifice was loosely installed in the connection, preventing the sealing surfaces from seating. The extra orifice was removed, and the connection was acceptable.

f. At forward skirt stringer 14, pipe assembly, P/N 1B64155-1, leaked at the B-nut connection to the actuation control module. The B-nut was retorqued and accepted.

Engineering comments noted several parts shortages at the start of the test. Seven interim use actuation control modules, P/N 1B65292-501, were installed per SEO's 1B65292-501-005 and -009, in place of actuation control modules 403A75A1, 404A9, 404A43, 404A44, 411A2, 411A3, and 411A30, P/N 1B66692-1. The continuous vent regulator module 411A32, P/N 1B65649-1, was not installed. Additional parts shortages were noted at the continuation of the test on 29 March. An interim use continuous vent module, P/N 1B51753-501-007, was installed per SEO 1B67193-004 in place of continuous vent module 411A32, P/N 1B67193-501. Interim use pipe assemblies, P/N's 1B64602-1, 1B64603-1, and 1B64618-1, were installed per SEO 1B52500-007 in place of pipe assemblies, P/N 1B64606-1, 1B64607-1, 1B64608-1, and 1B64609-1, expander, P/N MC239C4-2, tee, P/N MC162C4, and restrictor, P/N 1B40622-505. These interim use parts were to be replaced by flight parts prior to static firing.

The previously noted FARR A248626, was the only failure and rejection report written during this procedure. Seven revisions were made to the procedure for the following:

a. Three revisions changed the required GSE stage 4 line pressures and pneumatic control sphere pressures to provide 750, +0, -25,

4.2.20 (Continued)

psia for the sphere integrity test and the system decay test, and 700 ± 25 psia for the system leak checks. The pressure requirements had been 1700 ± 50 psia for the integrity test, 1450 ± 50 psia for the decay test, and 1500 ± 100 psia for the leak checks. The changes were made to meet the pressure test restrictions specified in revision 1 of TAN 11049.

b. One revision changed the leakage measurements to be made on the LOX vent and relief valve opening piston seal, and lowered the allowable leakage from 370 scim to 150 scim, to comply with the applicable specification control drawing requirements.

c. One revision disconnected purge line, P/N 1B67150-1, at the cross to the LOX tank pressure sensing line, and capped it prior to the test; and one other revision reconnected it after the test.

d. One revision deleted the word "vent" from the instruction to check the LOX prevalve shaft seal leakage through the position indicator switch housing vent. There was no vent in this housing.

4.2.21 Propellant Utilization System Calibration (1B64367 F)

This manual calibration procedure verified the operation of the propellant utilization system, and provided the necessary calibration prior to the automatic checkout of the system. For calibration purposes, the GSE Model DSV-4B-248 propellant utilization test set (PUT/S), P/N 1A68014-1, was used to provide varying capacitance inputs to the propellant utilization electronics assembly, simulating the outputs of the LOX and LH_2 mass probes under varying propellant load conditions. The particular items involved in this test were the propellant utilization electronics assembly (PUEA) 411A92A6, P/N 1A59538-525, S/N 13, and the static inverter-converter 411A92A7, P/N 1A66212-505.3, S/N 18.

The calibration procedure was accomplished on 13 March 1967, and was accepted on the same date. The PUT/S was connected to the PUEA 411A92A6 and the static inverter-converter 411A92A7, and the stage power was turned on. Measurements were made of the inverter-converter output voltages and operating frequency, as shown in Test Data Table 4.2.21.1.

The PUEA bridge calibrations were conducted next. Simulated empty conditions were first established with the PUT/S. The PUEA LH_2 bridge was calibrated for the empty condition by adjusting the PUT/S ratiometer to null the LH_2 bridge tap voltage, at a ratiometer setting of 0.02005, and then adjusting the PUEA R2 potentiometer to null the LH_2 bridge output. The PUEA LOX bridge was calibrated for the empty condition by adjusting the PUT/S ratiometer to null the LOX bridge tap voltage, at a ratiometer setting of 0.02022, and then adjusting the PUEA R1 potentiometer to null the LOX bridge output. Simulated full conditions were then established with the PUT/S, at a PUT/S C1 capacitor (LH_2) setting of 210 picofarads, and a PUT/S C2 capacitor (LOX)

4.2.21 (Continued)

setting of 128 picofarads. The PUT/S ratiometer was set to 0.84018. The PUEA LH_2 bridge was calibrated for the full condition by adjusting the PUEA R4 potentiometer to null the LH_2 bridge output, and the PUEA LOX bridge was calibrated for the full condition by adjusting the PUEA R3 potentiometer to null the LOX bridge output.

Data acquisition was verified by establishing simulated empty and full conditions with the PUT/S, and then adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs. As shown in the Test Data Table, the ratiometer settings obtained were all within the required limits. Bridge slew checks were conducted by establishing simulated 1/3 and 2/3 slew conditions with the PUT/S, and adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs for each condition. As shown in the Test Data Table, the ratiometer settings obtained were all within the required limits.

Before accomplishing the reference mixture ratio (RMR) calibration, the difference between the previously determined LH_2 empty and LOX empty ratiometer settings was determined to be -0.000005. This difference was multiplied by 98.4 vdc to give a V1 reference voltage of -0.000492 vdc. Simulated empty conditions were established with the PUT/S, and the PUEA residual empty bias R6 potentiometer was adjusted to null the RMR bias voltage. Simulated full conditions were then established with the PUT/S, at a PUT/S C1 capacitor (LH_2) setting of 210 picofarads and a PUT/S C2 capacitor (LOX) setting of 128 picofarads. The PUEA residual full bias R5 potentiometer was then adjusted to null the RMR bias voltage. For a fuel boiloff bias calibration, simulated boiloff conditions were established with the PUT/S,

4.2.21 (Continued)

at a PUT/S C1 capacitor (LH_2) setting of 227 picofarads and a PUT/S C2 capacitor (LOX) setting of 128 picofarads. The PUEA fuel bias R7 potentiometer was then adjusted to null the RMR bias voltage.

PUEA LH_2 and LOX bridge linearity checks were conducted by setting the PUT/S capacitors to specific values and adjusting the PUT/S ratiometer to null the PUEA bridge outputs. PUT/S capacitor C1 was set for the LH_2 bridge checks, and PUT/S capacitor C2 was set for the LOX bridge checks. As shown in the Test Data Table, the PUT/S ratiometer settings obtained were all within the required limits for both checks. For a fuel boiloff bias limitation check, the PUEA fuel bias R7 potentiometer was adjusted fully clockwise, and the PUT/S C2 capacitor (LOX) was set to zero picofarads. The PUT/S C1 capacitor (LH_2) was then adjusted to null the RMR bias voltage. The C1 capacitor null setting was 50.9 picofarads, meeting the 25.51 picofarads minimum requirement. The PUT/S C1 capacitor (LH_2) was then set to zero picofarads, and the LH_2 boiloff bias voltage was measured as 12.443 vdc. This was an information measurement, and no limits were specified.

For a verification of the hardwire loading circuits, simulated full conditions were established with the PUT/S, at a PUT/S C1 capacitor (LH_2) setting of 210 picofarads and a PUT/S C2 capacitor (LOX) setting of 128 picofarads. The PUT/S ratiometer was set to 0.00000, and the hardwire loading circuit PUEA LH_2 and LOX bridge output voltages were measured as 22.98 vdc each, meeting the requirement of 23.52 $\pm$ 2.0 vdc each. This completed the propellant dispersion system calibration. It was noted that during this procedure approximately two cycles were accumulated on the PUEA R1 (LOX) potentiometer, and approximately five cycles were accumulated on the PUEA R2 (LH_2) potentiometer.

4.2.21 (Continued)

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during this procedure, and no failure and rejection reports were written. Two revisions were made to the procedure for the following:

a. One revision added the GSE Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the End Item Equipment list, as operation of the recorder was required any time vehicle power was on.

b. One revision changed the wording of one paragraph to update the procedure to agree with the "as run" condition of Stage 1008.

4.2.21.1 Test Data Table, Propellant Utilization System Calibration

Static Inverter-Converter Measurements

Function	Measurement	Limits
5.0 vdc Output Voltage (vdc)	4.94	4.50 to 5.10
21.0 vdc Output Voltage (vdc)	21.4	20.00 to 22.50
28.0 vdc Output Voltage (vdc)	27.3	26.00 to 30.00
V/P Excitation Voltage (vdc)	49.3	48.00 to 51.00
115 vrms Monitor Voltage (vdc)	2.7	2.28 to 3.18
117 vdc Output Voltage (vdc)	120.5	115.0 to 122.5
Test Point 2 Voltage (vdc)	21.5	20.00 to 22.50
Operating Frequency (Hz)	399.1	394 to 406

Data Acquisition

Function	PUT/S Ratiometer	Limits
LH_2 Empty	0.00034	0.00000 to 0.00168
LOX Empty	0.000335	0.00000 to 0.00168
LH_2 Full	0.84110	0.83940 to 0.84276
LOX Full	0.84114	0.83940 to 0.84276

Bridge Slew Checks

Function	PUT/S Ratiometer	Limits
LH_2 1/3 Slew	0.27441	0.25036 to 0.31036
LH2 2/3 Slew	0.56048	0.53072 to 0.59072
LOX 1/3 Slew	0.26985	0.25036 to 0.31036
LOX 2/3 Slew	0.56499	0.53072 to 0.59072

4.2.21.1 (Continued)

LH_2 Bridge Linearity Check

PUT/S C1 Value	PUT/S Ratiometer	Limits
50 pf	0.20018	0.19858 to 0.20194
100 pf	0.39984	0.39883 to 0.40219
150 pf	0.59966	0.59909 to 0.60245
200 pf	0.80076	0.79935 to 0.80271
210 pf	0.84107	0.83940 to 0.84276

LOX Bridge Linearity Check

PUT/S C2 Value	PUT/S Ratiometer	Limits
20 pf	0.13095	0.12974 to 0.13310
50 pf	0.32797	0.32687 to 0.33023
70 pf	0.45905	0.45829 to 0.46165
100 pf	0.65625	0.65541 to 0.65877
128 pf	0.84114	0.83940 to 0.84276

4.2.22 Exploding Bridgewire System (1B66566 A)

This automatic procedure verified the integrity of the exploding bridgewire (EBW) system, and demonstrated the capability of the EBW system to initiate ullage rocket ignition and jettison when commanded by the instrument unit during flight. The particular items involved in this test were:

Part Name	Ref. Location	P/N	S/N
Ullage Rocket Ignition System			
EBW Firing Unit	404A47A1	40M39515-113	245
EBW Firing Unit	404A47A2	40M39515-113	240
Pulse Sensor **	404A47A4A1	40M02852	-
Pulse Sensor **	404A47A4A2	40M02852	-
** on Pulse Sensor Bracket Assembly	404A47A4	1B52640-1	2
Ullage Rocket Jettison System			
EBW Firing Unit	404A75A1	40M39515-113	238
EBW Firing Unit	404A75A2	40M39515-113	239
Pulse Sensor *	404A75A10A1	40M02852	375
Pulse Sensor *	404A75A10A2	40M02852	376
* on Pulse Sensor Bracket Assembly	404A75A10	1A97791-501.1	1

This procedure was accomplished on 14 March 1967, and was accepted on 23 March 1967. Throughout this procedure, the charged condition of each EBW firing unit was determined by verifying that the firing unit voltage indication measured 4.2 $\pm$ 0.3 vdc, while the uncharged or discharged condition was determined by verifying that the voltage indication measured 0.0 $\pm$ 0.3 vdc.

The stage power setup, H&CO 1B66560, was accomplished, and initial conditions were established for the test. An EBW pulse sensor self test was conducted first. The pulse sensor power was turned on, and the four pulse sensors were all reset and verified to be OFF. The pulse sensor self test was turned on, and the pulse sensors were all verified to be ON. The pulse sensors were then reset and again verified to be OFF.

4.2.22 (Continued)

The ullage ignition EBW firing units were tested next. The charge ullage ignition command was turned on, and it was verified that the command functioned properly by determining that both ullage ignition EBW firing units were charged while both ullage jettison EBW firing units were uncharged. The fire ullage ignition command was turned on, and the proper functioning of this command was verified by determining that both ignition pulse sensors were ON while both jettison pulse sensors were OFF, and that both ullage ignition EBW firing units were discharged. The charge command and the firing command were reset, and the pulse sensors were reset and verified to be OFF.

The ullage jettison EBW firing units were tested in the same way, using the charge ullage jettison and fire ullage jettison commands, and verifying that only the ullage jettison EBW firing units were charged and discharged, and that the jettison pulse sensors were ON after the fire command.

The firing unit disable test was conducted next. The EBW ullage rocket firing unit disable command was turned on, and all four EBW firing units were determined to be uncharged. The charge ullage ignition and charge ullage jettison commands were turned on and it was determined that all four EBW firing units remained uncharged. This verified that the disable command would prevent the firing units from charging. The firing unit disable command was then turned off, and it was determined that all four firing units were properly charged. The EBW ullage rocket firing unit disable command was then turned back on. The fire ullage ignition and fire ullage jettison commands were turned on, and it was determined that all four pulse sensors remained OFF, and that all four firing units were discharged. This

4.2.22 (Continued)

verified that the disable command would discharge the charged firing units and would prevent the units from firing. The charge command and fire command were reset, the firing unit disable command was turned off, and the pulse sensor power was turned off.

The EBW pilot relay reset test was conducted next. In a series of checks, the charge ullage ignition, charge ullage jettison, fire ullage ignition, and fire ullage jettison commands were individually turned on and then reset. It was verified that the EBW pilot relay reset indication was OFF after each command was turned on, and the pilot relay reset indication was ON after each command was reset. This completed the exploding bridgewire system test. It was noted that the switch selector was used 42 times during the procedure, and that each of the ignition and jettison firing units was discharged 3 times.

Engineering comments noted that the continuous vent module 411A32, P/N 1B67193-501, was not installed during this test. This shortage affected only the initial conditions scan part of the procedure. No problems were encountered during this test, and no failure and rejection reports were written.

Five revisions were made to the procedure for the following:

a. One revision corrected the Running Time/Cycle Record paragraph to note that the EBW firing units, P/N 40M39515-113, and the switch selector, P/N 50M67864-5, were cycle significant items; to provide instructions for filling out and submitting Time/Cycle Data Sheets (DAC Form 60-736); and to note that at the completion of the test the computer would print out the total number of operating cycles for each cycle significant item.

4.2.22 (Continued)

b. One revision deleted two print statements and changed three other statements to be non-intervene statements, to reduce the time between applying the firing unit disable command and the fire commands when demonstrating that the disable command would prevent the firing of the EBW firing units.

c. One revision changed the main program re-entry point after a firing unit disable command set malfunction subroutine, to ensure that the EBW firing units would be charged before repeating the firing unit disable command test.

d. One revision changed the main program re-entry point after a firing unit disable command reset malfunction subroutine, to make the procedure agree with the test requirements drawing 1B64705.

e. One revision deleted a function of the LH_2 continuous vent module, P/N 1B67193-501, from the initial conditions scan, as a malfunction typeout occurred because this unit was not installed.

4.2.23 Auxiliary Propulsion System (1B66569 A)

As flight APS modules were not installed during VCL testing, this automatic checkout used the Model DSV-4B-188 APS simulators to verify the integrity of the stage wiring associated with APS functions, and to verify the correct receipt of command signals routed from the GSE automatic checkout system, through the attitude control relay packages, to the APS electrical interfaces. The Model DSV-4B-188 simulators did not functionally simulate the APS modules, but provided suitable loads at the electrical interface to determine that stage mounted components of the APS functioned properly. This test involved all stage mounted components of the auxiliary propulsion system, in particular the attitude control relay packages, P/N 1B57731-1, S/N 337 at reference location 404A51A4, and S/N 349 at reference location 404A71A19.

This procedure was satisfactorily accomplished by the first test run on 14 March 1967, and was accepted on 23 March 1967. The data in this paragraph and in Test Data Table 4.2.23.1 are from this test run.

The stage power setup, H&CO 1B66560, was accomplished, and initial conditions were established for the test. The GSE instrument unit substitute -28 vdc power supply was turned on and the voltage was measured as -29.52 vdc, within the -28.0 $\pm$ 2.0 vdc limits. The APS firing enable command, and the APS bus power, were turned on. A series of tests were conducted to verify the proper operation of the APS engine valve solenoids. Attitude control nozzle commands were turned on and the appropriate APS engine valve open indication voltage was measured through both the AO and BO instrumentation multiplexers. The attitude control nozzle command was then turned off, and the valve open indication voltage was again measured. As shown in the Test Data Table, the

4.2.23 (Continued)

results of these tests were all acceptable. The 70 pound ullage engine command 1 was turned on and off, while the ullage engine relay reset was verified to operate properly. The instrument unit substitute -28 vdc power supply was turned off, and the voltage was measured as 0.00 vdc, within the 0.0 ± 0.5 vdc limits. The APS firing enable command, and the APS bus power, were turned off, completing the procedure. The computer typeout indicated that the switch selector was used 23 times during this test.

Engineering comments noted that there were several parts shortages during this test. The continuous vent module 411A32, P/N 1B67193-501, was not installed. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed per SEO 1A49590-513-018 in place of LOX vent and relief valve 424A1, P/N 1A48312-505. An interim use directional control valve, P/N 1A49988-1-002, was installed per SEO 1A49988-1-002 in place of directional control valve 411A29, P/N 1A49988-1. These shortages affected only the initial conditions scan part of the test.

The only problem encountered during this procedure was an illegal function number in the program. This was corrected on-line, and the procedure was satisfactorily completed. No failure and rejection reports were written during this procedure. Four revisions were made to the procedure for the following:

a. Two revisions changed the APS engine valve open indication voltage limits for the attitude control nozzle on commands, to agree with the test requirements drawing, 1B64692-1. The APS 1 voltages were changed from 4.2 ± 0.30 vdc to 4.3 ± 0.25 vdc, and the APS 2 voltages were changed from 4.0 ± 0.30 vdc to 4.1 ± 0.25 vdc.

4.2.23 (Continued)

b. One revision changed the function number to measure the aft 5 volt excitation module voltage, to correct a program error.

c. One revision deleted measurements of the LH_2 continuous vent module, P/N 1B67193-501, from the initial conditions scan, as malfunction indications were caused by the unit not being installed.

4.2.23.1 Test Data Table, Auxiliary Propulsion System

Attitude Control Nozzle Command		APS Engine	Valve Open Indication Voltage (vdc) AO Multi.	BO Multi.	Limits
Nozzle I IV	On	1-1 or 1-3	4.21	4.29	4.3 ± 0.25
	Off	1-1 or 1-3	0.00	0.00	0.0 ± 0.25
Nozzle I II	On	1-1 or 1-3	4.18	4.22	4.3 ± 0.25
	Off	1-1 or 1-3	0.00	0.00	0.0 ± 0.25
Nozzle I P	On	1-2	4.26	4.32	4.3 ± 0.25
	Off	1-2	0.00	0.00	0.0 ± 0.25
Nozzle III II	On	2-1 or 2-3	4.14	4.20	4.1 ± 0.25
	Off	2-1 or 2-3	0.00	0.00	0.0 ± 0.25
Nozzle III IV	On	2-1 or 2-3	4.13	4.19	4.1 ± 0.25
	Off	2-1 or 2-3	0.00	0.00	0.0 ± 0.25
Nozzle III P	On	2-2	4.18	4.24	4.1 ± 0.25
	Off	2-2	0.00	0.00	0.0 ± 0.25

4.2.24 Propellant Utilization System (1B66567 A)

This automatic checkout procedure verified the ability of the propellant utilization system to determine and control the engine propellant flow mixture ratio in a manner that would ensure simultaneous propellant depletion, and to provide propellant level information to control the fill and topping valves during LOX and LH_2 loading. This test involved all components of the stage propellant utilization system, including the propellant utilization ratio valve in the J-2 engine, and the following:

Part	Ref. Location	P/N	S/N
Propellant Utilization Electronics Assembly (PUEA)	411A92A6	1A59358-525	13
Static Inverter-Converter	411A92A7	1A66212-505.3	18
LOX Mass Probe	406A1	1A48430-509-010	C1
LH_2 Mass Probe	408A1	1A48431-505	D3
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D50
LOX Fast Fill Sensor	406A2C5	1A68710-1	D97
LOX Fast Fill Control Unit	404A72A5	1A68710-511.1	E12
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D92
LH_2 Fast Fill Sensor	408A2C5	1A68710-1	E149
LH_2 Fast Fill Control Unit	411A92A43	1A68710-509	D84

This procedure was initially accomplished on 14 and 15 March 1967, and was accepted on 20 March 1967. Subsequent to this, rework of the LOX tank flange to eliminate leakage (reference FARR A248632) required the disconnection of the LOX tank mass probe electrical feed through. After this was reconnected, a second issue of the procedure was accomplished and accepted on 31 March 1967. The specific measurement values presented in this narration and in Test Data Table 4.2.24.1 are from this second issue test run.

The stage power setup procedure, H&CO 1B66560, was accomplished, and initial conditions were established for the test. LOX and LH_2 ratio values, the residual bias voltage value, and the LH_2 boiloff bias voltage value, were

4.2.24 (Continued)

obtained from the manual propellant utilization system calibration procedure, H&CO 1B64367, and loaded into the computer. From the ratio values, nominal test values were computed for the LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages. The loaded and computed values are shown in the Test Data Table.

A propellant utilization (PU) system test was conducted first. Power was applied to the PU inverter and electronics, and measurements were made of the forward bus 2 voltage and the static inverter-converter output voltages and operating frequency. As shown in the Test Data Table, these measurements were all within the required limits. The servo bridge balanced and ratio valve null test was conducted next. The ratio valve position voltage was measured through the BO telemetry multiplexer, and the LOX and LH_2 coarse and fine mass voltages were measured through both the AO and BO telemetry multiplexers. As shown in the Test Data Table, the ratio valve position voltage was within the required null position limits, and the mass voltages were within the required limits of the appropriate computed empty mass voltages.

The PU loading test was conducted next. The boiloff bias indication was verified to be OFF, and the LH_2 boiloff bias signal voltage was measured. The boiloff bias cutoff was turned on, the bias indication was verified to be ON, and the bias signal voltage was again measured. The boiloff bias cutoff was turned back off, the bias indication was verified to again be OFF, and the bias signal voltage was again measured. The GSE power supply for the LH_2 and LOX loading potentiometers was turned on, and the power supply voltage was measured. Measurements were then made of the LOX and LH_2

4.2.24 (Continued)

loading potentiometer sense voltages and signal voltages. The measurements of the loading potentiometer signal voltages were repeated with the LOX and LH_2 bridge 1/3 checkout relays turned on, and again with the relays turned back off. The GSE power was turned off, and the LOX and LH_2 loading potentiometer sense voltages were again measured. As shown in the Test Data Table, the sense voltages were within the required $\pm$ 0.4 vdc limit of the GSE power supply voltage when the power was ON; the signal voltages were within the required $\pm$ 0.5 vdc limit of the appropriate computed empty loading voltage with the checkout relays OFF, and within the required $\pm$ 2.0 vdc limit of the appropriate computed 1/3 coarse mass loading voltage with the checkout relays ON; and the sense voltage was within the required 0.0 $\pm$ 0.75 vdc limits with the GSE power OFF.

The servo balance bridge gain test was conducted next. The ratio valve position was measured through the BO telemetry multiplexer, and measurements were made of the LOX and LH_2 coarse and fine mass voltages through both the AO and BO telemetry multiplexers. These measurements were repeated with the LOX and LH_2 bridge 1/3 checkout relays ON, with the bridge 2/3 checkout relays ON, with the bridge 2/3 checkout relays OFF, and again with the bridge 1/3 checkout relays OFF. For each measurement, the ratio valve position voltage was compared to the voltage measured during the ratio valve null test, and the mass voltages were compared to the appropriate computed mass voltages. As shown in the Test Data Table, all of these measurements were within the requried limits.

The overfill and fast fill sensor test checked the operation of the LOX and LH_2 tank overfill and fast fill sensors and their associated control units

4.2.24 (Continued)

by verifying that the proper indicators were registering under ambient (dry) conditions and under simulated wet conditions of the sensors. All four sensors and their control units responded properly during this test.

For a PU valve movement test, fifty second plus valve slew checks and fifty second minus valve slew checks were conducted. The pre-slew ratio valve position voltage was measured before each of the slew checks was started. The system test valve position signal was measured before the plus valve slew checks were started, and was verified to be -1 ± 0.02 vdc before the minus valve slew checks were started. During each slew, the ratio valve position voltage was measured at 3, 5, 8, 20, and 50 seconds after the slew started, to determine the change in the position voltage from the pre-slew measurement. Each slew was conducted twice, with the ratio valve position voltages measured through the AO telemetry multiplexer the first time, and through the BO telemetry multiplexer the second time. As shown in the Test Data Table, all of the measurements were within the required limits.

The last part of the procedure was a PU activate test. Measurements were made through both the AO and BO telemetry multiplexers during this test. The ratio valve position voltage was measured, the LOX bridge 1/3 checkout relay was turned on, and the LOX coarse mass voltage was measured. The propellant utilization system was turned on, the ratio valve position voltage was measured, the PU system was turned off, and the ratio valve position voltage was remeasured. The LOX bridge 1/3 checkout relay was turned off and the LOX coarse mass voltage and the ratio valve position voltage were again measured. The LH_2 bridge 1/3 checkout relay was turned on, and the LH_2 coarse mass voltage was measured. The propellant utilization system was turned on, the

4.2.24 (Continued)

ratio valve position voltage was measured, the PU system was turned back off, and the ratio valve position voltage was again measured. The LH_2 bridge 1/3 checkout relay was turned off, and the LH_2 coarse mass voltage and the ratio valve position voltage were remeasured. As shown in the Test Data Table, all of these measurements were within the required limits. It was noted that the LOX and LH_2 bridge potentiometers were each cycled three times during this procedure.

Engineering comments noted two parts shortages during the second issue run of this procedure. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed per SEO 1A49590-513-018 in place of LOX vent and relief valve 424A1, P/N 1A48312-505. An interim use continuous vent module, P/N 1B51753-501-007, was installed per SEO 1B67193-004 in place of continuous vent module 411A32, P/N 1B67193-501.

Program difficulties encountered during the first issue test run were corrected for this second issue test run. No stage problems were encountered during either test run, and no failure and rejection reports were written. Fourteen revisions were made to the second issue of the procedure for the following:

a. Two revisions added notations to the System Description and H&CO Description paragraphs, to conform to test requirements drawing 1B64703. These noted that the system for the SV stages contained an additional bias circuit to compensate for fuel boiloff during the coast period of flight, and that the boil-off voltage was verified to be within a specified tolerance during the procedure.

b. One revision added drawing 60M67864-5, Switch Selector, to the Customer Documents list, to conform to the test requirements drawing.

4.2.24 (Continued)

c. Two revisions changed the tolerance on the boiloff bias voltage off condition from 0 ± 2.0 vdc and 0 ± 1.0 vdc, to 0 ± 2.5 vdc, at two points in the program, to conform to test requirements drawing 1B64703.

d. One revision corrected the valve movement test acceptance criteria table, to conform to the test requirements drawing, as incorrect limits were listed. The correct limits were carried in the program printout for this test.

e. One revision changed two delay times from 35 milliseconds to 30 milliseconds, to conform to the test requirements drawing.

f. Two revisions changed the program at several places to add measurements of the ratio valve position voltage through the BO multiplexer, as well as through the AO multiplexer, as the BO multiplexer measurement is a mission (flight) control parameter.

g. Three revisions corrected programming errors. Three SI function numbers were changed to the proper SV function numbers; five printout commands were changed to print the correct computed voltage changes, rather than the directly measured voltages; and one post backup statement was deleted, as the backup would not load.

h. Two revisions concerned the LH_2 continuous vent module 411A32, P/N 1B67193-501. One of these revisions, originally written against the first issue of the procedure, deleted two functions of the module from the initial conditions scan, as this module was not installed at that time. The second revision deleted the first revision, as an interim use module, P/N 1B51753-501-007, was installed and could be tested.

4.2.24.1 Test Data Table, Propellant Utilization System

Loaded Values (from H&CO 1B64367)

LOX Empty Ratio	0.000	LH_2 Empty Ratio	0.000
LOX Wiper Ratio	0.020	LH_2 Wiper Ratio	0.020
LOX 1/3 Bridge Slew Ratio	0.270	LH_2 1/3 Bridge Slew Ratio	0.274
LOX 2/3 Bridge Slew Ratio	0.565	LH_2 2/3 Bridge Slew Ratio	0.560

Residual Bias Empty Voltage	0.000 vdc
LH_2 Boiloff Bias Voltage	12.443 vdc

4.2.24.1 (Continued)

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.000	LH_2 Empty	0.000
LOX 1/3 Mass	1.348	LH_2 1/3 Mass	1.372
LOX 2/3 Mass	2.827	LH_2 2/3 Mass	2.798

Computed Fine Mass Voltages (vdc)

LOX Empty	1.953	LH_2 Empty	1.953
LOX 1/3 Mass	1.587	LH_2 1/3 Mass	1.108
LOX 2/3 Mass	2.588	LH_2 2/3 Mass	3.164

Computed Loading Voltages (vdc)

LOX Empty	0.000	LH_2 Empty	0.000
LOX 1/3 Coarse Mass	7.547	LH_2 1/3 Coarse Mass	7.684

PU System Power Test

Function	Measurement	Limits
Forward Bus 2 Voltage (vdc)	28.16	28.0 ± 2.0
Inv.-Conv. 115 vrms Output (vrms)	114.229	115.0 ± 3.4
Inv.-Conv. 21 vdc Output (vdc)	21.579	21.25 ± 1.25
Inv.-Conv. 5 vdc Output (vdc)	4.974	4.8 ± 0.3
Inv.-Conv. Operating Frequency (Hz)	398.922	400.0 ± 6.0

Bridge Balanced and Ratio Valve Null Test

Function	AO (vdc)	BO (vdc)	Limits (vdc)
Ratio Valve Position Voltage	-	2.625	2.65 ± 0.12
LOX Coarse Mass Voltage	-0.005	-0.005	0.000 ± 0.1
LOX Fine Mass Voltage	1.934	1.929	1.953 ± 0.4
LH_2 Coarse Mass Voltage	-0.005	-0.005	0.000 ± 0.1
LH_2 Fine Mass Voltage	1.953	1.953	1.953 ± 0.4

PU Loading Test

Function	Measurement (vdc)	Limits (vdc)
LH_2 Boiloff Bias Voltage, Off	0.55	0.0 ± 2.5
LH_2 Boiloff Bias Voltage, On	13.46	12.433 ± 2.5
LH_2 Boiloff Bias Voltage, Off	0.63	0.0 ± 2.5
GSE Power Supply Voltage	28.759	28.0 ± 2.0

4.2.24.1 (Continued)

Loading Potentiometer Function	LOX Pot. (vdc)	LH_2 Pot. (vdc)
Sense Voltage, GSE Power On	28.799	28.759
Signal Voltage, Relays Off	0.000	0.191
Signal Voltage, Relays On	7.383	7.520
Signal Voltage, Relays Off	0.027	0.000
Sense Voltage, GSE Power Off	0.079	0.039

Servo Balance Bridge Gain Test

Function	AO (vdc)	BO (vdc)	Limits (vdc)
Ratio Valve Position Voltage	-	2.609	2.625 ± 0.12
LOX Coarse Mass Voltage	-0.005	0.000	0.000 ± 0.1
LOX Fine Mass Voltage	1.934	1.934	1.953 ± 0.4
LH_2 Coarse Mass Voltage	-0.010	0.000	0.000 ± 0.1
LH_2 Fine Mass Voltage	1.958	1.963	1.953 ± 0.4
- 1/3 Checkout Relays On -			
Ratio Valve Position Voltage	-	2.574	2.625 ± 0.12
LOX Coarse Mass Voltage	1.343	1.338	1.348 ± 0.1
LOX Fine Mass Voltage	1.460	1.460	1.587 ± 0.4
LH_2 Coarse Mass Voltage	1.362	1.362	1.372 ± 0.1
LH_2 Fine Mass Voltage	1.011	1.011	1.108 ± 0.4
- 2/3 Checkout Relays On -			
Ratio Valve Position Voltage	-	2.538	2.625 ± 0.12
LOX Coarse Mass Voltage	2.822	2.822	2.827 ± 0.1
LOX Fine Mass Voltage	2.358	2.358	2.588 ± 0.4
LH_2 Coarse Mass Voltage	2.798	2.793	2.798 ± 0.1
LH_2 Fine Mass Voltage	2.793	2.793	3.164 ± 0.4
- 2/3 Checkout Relays Off -			
Ratio Valve Position Voltage	-	2.574	2.625 ± 0.12
LOX Coarse Mass Voltage	1.328	1.343	1.348 ± 0.1
LOX Fine Mass Voltage	1.460	1.465	1.587 ± 0.4
LH_2 Coarse Mass Voltage	1.362	1.367	1.372 ± 0.1
LH_2 Fine Mass Voltage	1.011	1.011	1.108 ± 0.4
- 1/3 Checkout Relays Off -			
Ratio Valve Position Voltage	-	2.609	2.625 ± 0.12
LOX Coarse Mass Voltage	-0.005	-0.010	0.000 ± 0.1
LOX Fine Mass Voltage	1.929	1.929	1.953 ± 0.4
LH_2 Coarse Mass Voltage	-0.005	-0.005	0.000 ± 0.1
LH_2 Fine Mass Voltage	1.963	1.948	1.953 ± 0.4

4.2.24.1 (Continued)

PU Valve Movement Test

Function	AO (vdc)	BO (vdc)	Limits (vdc)
- 50 Second Plus Valve Slew -			
Ratio Valve Position Voltage	2.620	2.620	2.625 ± 0.12
Test Valve Position Signal	0.999	0.994	1.00 ± 0.02
Voltage Change at T+3 Seconds	-0.323	-0.323	-0.154 to -0.480
Voltage Change at T+5 Seconds	-0.405	-0.405	-0.201 to -0.559
Voltage Change at T+8 Seconds	-0.446	-0.446	-0.225 to -0.559
Voltage Change at T+20 Seconds	-0.467	-0.467	-0.395 to -0.559
Voltage Change at T+50 Seconds	-0.457	-0.467	-0.395 to -0.559
- 50 Second Minus Valve Slew -			
Ratio Valve Position Voltage	2.61	2.62	2.625 ± 0.12
Voltage Change at T+3 Seconds	0.298	0.297	0.154 to 0.480
Voltage Change at T+5 Seconds	0.380	0.374	0.201 to 0.559
Voltage Change at T+8 Seconds	0.421	0.410	0.225 to 0.559
Voltage Change at T+20 Seconds	0.437	0.436	0.395 to 0.559
Voltage Change at T+50 Seconds	0.437	0.436	0.395 to 0.559

PU Activate Test

Function	AO (vdc)	BO (vdc)	Limits (vdc)
Ratio Valve Position Voltage	2.620	2.620	2.625 ± 0.12
LOX Coarse Mass Voltage, Relay On	1.343	1.343	1.348 ± 0.1
Ratio Valve Position Voltage, PU On	0.112	0.112	1.0 max.
Ratio Valve Position Voltage, PU Off	2.584	2.589	1.5 min.
LOX Coarse Mass Voltage, Relay Off	0.000	0.000	0.000 ± 0.1
Ratio Valve Position Voltage	2.609	2.609	2.625 ± 0.12
LH_2 Coarse Mass Voltage, Relay On	1.362	1.362	1.372 ± 0.1
Ratio Valve Position Voltage, PU On	4.682	4.677	4.0 min.
Ratio Valve Position Voltage, PU Off	2.60	2.60	3.5 max.
LH_2 Coarse Mass Voltage, Relay Off	-0.010	0.000	0.000 ± 0.1
Ratio Valve Position Voltage	2.615	-	2.625 ± 0.12

4.2.25 J-2 Engine System Leak Check (1B59461 A)

The manual leak check of the J-2 engine system was subdivided into two separate procedures, the thrust chamber leak test, performed on 16 March 1967, and the J-2 engine leak checks, performed on 16 and 17 March 1967. The engine checks are further divided into the control sphere (bottle) integrity and leak check, and the start tank integrity and leak check. The procedure was accepted on 4 April 1967.

The engine equipment setup was accomplished on 15 March 1967, and the thrust chamber and ground support equipment setup was performed on 16 March 1967.

The thrust chamber leak check, performed first, involved pressurization of the chamber and leak checks of the system under pressure downstream of the main fuel and oxidizer valves, and leak checks of the engine portion of the LH_2 tank pressurization system. This was accomplished on 16 March 1967.

The thrust chamber leak check included leakage examination at the following connections: The LH_2 tank pressurization control module to engine injector connection, the thrust chamber purge and chilldown line from the aft umbilical disconnect to the engine thrust chamber, the automatic spark igniter (ASI) oxidizer valve to the ASI chamber connection, the fuel ASI chamber supply line connection, the main oxidizer valve and injector connection, the main fuel valve and fuel manifold connection, the start sphere pressurization line connection, the fuel manifold connection, the injector connection, and the two mainstage pressure switches to the injector connections. Shutdown and post-test procedures were then accomplished.

4.2.25 (Continued)

The start tank integrity and leak check was conducted on 17 March 1967. The start tank was pressurized to 100 psia and the operation of the vent valve was verified. The start tank was then pressurized to 200, and then to 400 psia, to verify that there was no gross leakage.

The start tank integrity test was performed by pressurizing the tank to 650 ± 25 psia and maintaining the pressure for three minutes. The tank was then vented to 600 ± 25 psia. During leak check of the start tank fill line, a leak was discovered at the aft umbilical upstream B-nut of pipe assembly, P/N 1B52566-1, inside the aft skirt. The B-nut was torqued and retested satisfactorily.

The following three revisions were incorporated into the procedure:

a. One revision substituted transducer locations for pipe assembly P/N's, as the P/N's vary with the J-2 engines, whereas the transducer positions do not.

b. One revision changed pipe assembly P/N's to conform to pipe assembly changes.

c. One revision, to clarify requirements, limited leak checks of pneumatic control package components to those checks specifically required by the propulsion engineer.

No parts shortages affected the test, and no FARR's were noted during the procedure.

4.2.26 Range Safety Receiver Checks (1B66565 A)

This automatic procedure verified the design integrity and operational capability of the range safety receivers and decoders. The range safety receiver checks consisted of AGC calibration curves, RF sensitivity checks, deviation (threshold) sensitivity checks, and open loop RF checks. Items involved in the test included range safety receivers, P/N 50M10697, S/N's 104 (receiver 1) and 167 (receiver 2), and range safety decoders, P/N 50M10698, S/N's 0133 (decoder 1) and 0092 (decoder 2).

The procedure was initiated, satisfactorily completed, and accepted on 16 March 1967. Only one test run was required. Malfunctions were typed out during the "Initial Condition Scan" portion of the procedure because the LH_2 continuous vent module, P/N 1B67193-501, was not installed. After a review of the above malfunctions, typed instructions directed the continuation of the test, and the range safety receivers were turned on.

The following parts were not installed at the start of testing: Continuous vent module, P/N 1B67193-501-F; LOX vent and relief valve, P/N 1A48312-505; and directional control fuel vent valve, P/N 1A49988-1. Interim use material (IUM) installed in lieu of the above were: LOX vent and relief valve, P/N 1A49590-513-018, per SEO 1A49590-513-018; and directional control fuel vent valve, P/N 1A49988-1-002, per SEO 1A49988-1-002. These parts were scanned in initial conditions only.

Test cable insertion loss values for A1 and B1, computed at 30.8 and 31.0 db, respectively, were converted into octal inputs as follows: A1, 75413; and B1, 76000; and loaded into the computer.

4.2.26 (Continued)

The AGC calibration check was then run twice, and the difference in AGC values at each step was determined for the AGC drift check. The AGC values were all acceptable, and the drift variations were well below the three per cent of full scale maximum limit. The results are found in the Test Data Table 4.2.26.1.

The destruct system test set was adjusted manually to 450 MHz and -17 dbm, and the signal generator output to 60 kHz, as indicated on the deviation meter. Connectors J2 and J6 of the directional power divider had 50 ohm loads connected to them until the open loop tests.

RF bandwidth checks of -3 and -60 db were conducted manually on both receivers. The test set was adjusted for a 2 $\pm$ 0.1 vdc indication on the low level numeric readout panel of the receiver under test. The resulting RF output value, with a 20 dbm value added, was recorded as the RF reference power level.

The bandwidth for the receiver under test was determined by increasing and decreasing the frequency of the test set until the 2 vdc low level T/M reference was indicated. The bandwidth was the difference between the upper and lower frequency. Bandwidth centering was found by obtaining the difference between the midpoint frequency and 450 MHz. The values found for receivers 1 and 2 are in Test Data Table 4.2.26.2.

To set up the deviation threshold checks, the manual operations procedure was used. The signal generator was reset to 450 MHz, and the test set output was set for a -63 dbm input into receiver 1. The LIN, the 560 ohm, the EXT, the kHz, and the DEV CAL switches were energized. The deviation knob

4.2.26 (Continued)

was adjusted until the counter indicated 5 kHz. The calibration knob was adjusted until the deviation meter indicated 5 kHz.

The DEV CAL switch was de-energized; the mode switch was set to CW; the CW tone switches were set to ON; and the deviation knob was adjusted until the deviation meter indicated 5 kHz. The CW tone switches were de-energized, and the mode switch was set to RECUR. The DSTS was thus set up for 5 kHz deviation, and the RESUME switch on the TOCC was then depressed to begin automatic deviation threshold checks.

During this test, the receiver input levels were fixed at -63 dbm for receiver 1, and -63.2 dbm for receiver 2. A series of checks determined the minimum input deviation frequency at which each receiver would respond to the range safety commands. For each command, the GSE test set was manually adjusted to a sequence of deviation frequencies increasing from 5 kHz as directed by the computer typeout. At each deviation frequency, the range safety control decoders were checked for the presence of the command signal from the appropriate receiver. Both receivers responded to all commands at minimum deviation frequencies well below the 50 kHz maximum limit.

As directed by computer printout/typeout, the manual operations procedure was used to set up the RF sensitivity checks. The LIN, the 560 ohm, the EXT, the 150 kHz, and the DEV CAL switches were energized. The deviation knob was adjusted until the counter read 60 $\pm$ 0.5 kHz, then the calibration knob was adjusted until the deviation meter indicated 60 kHz. The DEV CAL switch was de-energized, and the mode switch was set to CW. CW tone switches were set to ON, and the deviation knob was adjusted until the deviation meter

4.2.26 (Continued)

indicated 60 kHz. CW tone switches were de-energized, and the mode switch was set to RECUR. Thus, the range safety test set was set up for the automatic RF sensitivity checks. The RESUME switch on the TOCC was then depressed, and the automatic RF sensitivity checks begun.

A series of checks determined the minimum input signal level at which each of the receivers would respond to the range safety commands. For each command, the GSE test set output was manually adjusted to a sequence of levels increasing from -84.2 dbm, as directed by the computer typeout. This gave input levels increasing from -115.0 dbm for receiver 1, and increasing from -115.2 dbm for receiver 2. At each input level, the range safety control decoders were checked for the presence of the command signal from the appropriate receiver. Both receivers responded to minimum input levels below the -93 dbm maximum limit.

The computer typeout then directed that the open loop RF test setup be performed manually. The 50 ohm loads were disconnected from the J6 and J2 connectors of the power divider A97A56 at the vehicle, and cables, S/N's 411W21-P1 and 411W22-P1 were reconnected to J6 and J2 respectively. The loop switch was set to the open loop position. The antenna coaxial switch was set to the first position and the least sensitive receiver was then checked for low level signal strength. Test set output was increased in 1 db increments from -100 db until no further increase occurred. The second receiver was checked to the same db level within 3 vdc. Test set output for antennas No. 1 and 2 were -83 dbm and -85 dbm, respectively.

4.2.26 (Continued)

The same procedure was followed with the antenna coaxial switch in the second position. Test set output level for antenna No. 1 was -83 dbm and for antenna No. 2 was -85 dbm. The antenna coaxial switch was set in the first position and the test set signal generator output was adjusted until the least sensitive receiver signal strength indicated between -93 and -87 dbm. Proper signal strength was determined from the line printer data for AGC calibration run No. 2. Test set output level of -89 dbm was recorded.

The RESUME switch on the Test Operator Console was depressed to perform the RF open loop checks. Under open loop conditions, the low level signal strength (AGC telemetry voltage) of receiver 1 was 3.41 vdc, while that of receiver 2 was 3.18 vdc. The range safety commands were transmitted from the GSE test set, and checks of the decoder signals showed that both receivers responded properly to the open loop transmission. The PCM RF assembly power was turned on, and the range safety commands were again transmitted. Checks of the decoder signals showed that both receivers responded properly and were not adversely affected by the PCM RF transmission. The PCM RF assembly power and the range safety receiver power were turned off, completing the range safety receiver checks. The computer printout indicated that the switch selector had been used 44 times during this test run. Total running time was 1 hour, 7 minutes, 23.985 seconds for each receiver.

Eight revisions were written to modify the procedure as necessary. They included:

a. Revision one added the propulsion system display unit, P/N 1A65732-1, Model DSV-4B-238, to the list of optional end item test equipment.

4.2.26 (Continued)

b. One revision corrected an error in the test description portion of the H&CO, in the section on actuation measurement. The erroneous sentence called out repeating steps 3 and 7. This was changed to steps 3 through 7.

c. One revision corrected an error in Test Record Data Table 1, RF Bandwidth. Upper bandedge limits should have been "greater than 450 Mc," and lower bandedge limits should have been "less than 450 Mc." Both were listed as just "450 Mc."

d. A revision specified the correct step in the deviation threshold setup to use to change to 150 kHz.

e. A revision added a breakpoint at the beginning of the test, to verify that the range safety test set had been set up as required.

f. Another revision corrected an error in the program at the end of the AGC calibration checks.

g. A breakpoint was inserted when a malfunction occurred during the RC self test, to reset RS tone 5. The computer would have continued to loop as long as tone 5 was not set.

h. The final revision deleted a sequence resulting in a malfunction printout in the initial conditions scan, owing to the fact that the proper LH_2 continuous vent module was not installed.

AGC Calibration and Drift Checks

(% = Per Cent of Full Scale)

TEST SET OUTPUT (dbm)	RECEIVER 1 INPUT (dbm)	AGC 1 (%) RUN 1	AGC 1 (%) RUN 2	AGC 1 DRIFT (%)	RECEIVER 2 INPUT (dbm)	AGC 2 (%) RUN 1	AGC 2 (%) RUN 2	AGC 2 DRIFT (%)
-96.2	-127.0	11.78	11.99	0.21	-127.2	7.48	7.27	0.21
-89.2	-120.0	12.40	12.30	0.10	-120.2	7.38	7.48	0.10
-84.2	-115.0	13.13	13.42	0.29	-115.2	7.79	7.89	0.10
-79.2	-110.0	16.41	16.41	0.00	-110.2	9.53	9.02	0.51
-74.2	-105.0	23.57	23.89	0.31	-105.2	12.71	12.19	0.53
-69.2	-100.0	39.57	38.75	0.82	-100.2	21.33	20.51	0.82
-64.2	- 95.0	61.33	61.11	0.21	- 95.2	38.14	37.42	0.72
-59.2	- 90.0	69.12	68.91	0.21	- 90.2	63.16	62.97	0.20
-54.2	- 85.0	70.66	70.55	0.12	- 85.2	71.27	71.27	0.00
-49.2	- 80.0	71.17	70.96	0.21	- 80.2	72.40	72.40	0.00
-44.2	- 75.0	71.27	71.27	0.00	- 75.2	72.91	72.71	0.20
-39.2	- 70.0	71.37	71.27	0.10	- 70.2	73.01	73.01	0.00

Sensitivity Checks

	MINIMUM DEVIATION (kHz) RECEIVER 1	MINIMUM DEVIATION (kHz) RECEIVER 2	MINIMUM INPUT (dbm) RECEIVER 1	MINIMUM INPUT (dbm) RECEIVER 2
Arm and Engine Cutoff Command	15.0	12.5	-105.0	-105.2
Propellant Dispersion Command	15.0	12.5	-105.0	-105.2
Range Safety System Off Command	15.0	12.5	-110.0	-105.2

4.2.26.1 Test Data Table, Range Safety Receiver Manual Operations

-3 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC)	2.0 vdc	2.0 vdc	-
Reference RF Power Level	- 69.4 dbm	- 63.8 dbm	-
Upper Bandedge Frequency	450.155 MHz	450.156 MHz	-
Lower Bandedge Frequency	449.823 MHz	449.821 MHz	-
-3 db Bandwidth	332.0 kHz	335.0 kHz	340 ± 30 kHz
Bandwidth Centering	11.0 kHz	11.5 kHz	33.8 kHz max.

-60 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC)	2.0 vdc	2.0 vdc	-
Reference RF Power Level	- 69.4 dbm	- 63.8 dbm	-
Upper Bandedge Frequency	450.463 MHz	450.483 MHz	-
Lower Bandedge Frequency	449.510 MHz	449.538 MHz	-
-60 db Bandwidth	953.0 MHz	945.0 MHz	1.2 MHz max.

4.2.27 Propellant Tanks System Leak Check (1B59459 B)

The activities described in this document were accomplished on 18 March, 20 March, 29 and 30 March and 1 April 1967 with acceptance by Engineering taking place on 3 April 1967.

The first intent of the procedure was to vacuum check the LH_2 feed vacuum jacketed ducts, P/N's 1A49320-501-001, S/N 39, and 1A49320-507, S/N 22R; and the LH_2 chilldown supply duct, P/N 1A49966-501, S/N 019. Pressure leak checks were then performed on the common bulkhead monitoring lines, and on the tank connections. Seat leakage measurements were taken on the LH_2 and LOX fill and drain valves; the LH_2 and LOX prevalves; and the LH_2 vent, relief, and directional control valves. (See Table 4.2.27.1) The LOX chilldown pump, P/N 1A49423-507-009, S/N 1763, was also leak checked.

Prior to the start of the test, on 18 March 1967, a preliminary inspection of the common bulkhead fittings was performed. The fittings were found to have been plugged with potting material. This condition was corrected before the test proceeded.

Three non-flight interim use items were installed at the beginning of the testing sequence. IUM LH_2 control vent regulator module, P/N 1B51753-501-007, was installed in place of the flight module, P/N 1B67193-501-002F, and IUM LOX tank vent and relief valve, P/N 1A49590-513-018, was installed in place of flight part, P/N 1A49590-515. LH_2 tank directional control valve, P/N 1A49988-1-002, S/N 0022, was an interim use part. This was replaced by P/N 1B49988-1, S/N 23, per FARR A248634.

The test began with a checkout of the common bulkhead vacuum monitoring system, followed by the preparation of the propellant tanks for pressuriza-

4.2.27 (Continued)

tion. The vacuum checks were then begun. (See Table 4.2.27.1 for results) The ducts were checked to a vacuum indication of no more than 250 microns of mercury absolute.

The next operation involved pressurization of the common bulkhead to 2.5 ± 0.5 psig. All connections were leak checked, and transducer measurements D545 and D237 were checked. Both ambient as well as pressurized readings on these two pressure transducers were within tolerance.

The next four paragraphs pertained to the pressure leak checking of the pneumatic control system, and the LOX and LH_2 tanks. The tanks were proofed to 2.5 ± 0.4 psig. The USON leak detector was employed to determine leakage which could not be audibly detected.

The connections and seals in the tanks were leak checked, including: feed duct to prevalve and prevalve to engine; chilldown pump ports; chilldown and propellant lines; pressure sensing lines; umbilical supply lines; and probe feedthroughs.

The vent, fill and drain, and relief valves were then checked for seat leakage.

There were six revisions written to change the procedure as necessary. These revisions were documented in the Quality Engineering Log Sheet as follows:

a. The first revision changed leak check setups as necessary to enable personnel to make use of existing facilities.

b. A revision deleted the steps which pertained to checking the calibration of the VMP gages, as their accuracy had already been established.

4.2.27 (Continued)

c. The third revision deleted the requirement to measure and record the LOX chilldown pump to tank interface seal leakage. The change was made because no leakage was allowable.

d. According to the fourth revision, a tolerance of 6.1 scim maximum was noted as the allowable LH_2 fill and drain valve blade shaft seal leakage.

e. Two duct leak check steps were modified to include checkouts of transducer measurements D181, D182, D183, D184, C256, and C257. These checks were erroneously omitted from the procedure.

Two failure and rejection reports were written during the course of this test. They were:

a. FARR A248632, which noted that LOX tank flange, P/N 1A39307-57, was gouged, resulting in a blowing leak at that surface. The surface was machined to acceptable smoothness, correcting the leakage. This part was previously rejected and reworked during assembly by FARR A217200.

b. FARR A248642 reported on excessive blade shaft seal leakage from LH_2 fill and drain valve, P/N 1A48240-505, S/N 041. The valve was removed and replaced by valve, S/N 0118.

4.2.27.1 Test Data Table, Propellant Tanks System Leak Check

Vacuum Check:

Duct	P/N	S/N	Vacuum (microns of Hg)
LH_2 Feed Duct	1A49320-501	39	10
LH_2 Feed Duct	1A49320-507	42R	14
LH_2 Chilldown Supply Duct	1A49966-501	019	150

Valve Check:

Valve	P/N	S/N	Leakage (scim)
LOX Fill and Drain Valve	1A48240-501	0001	Main seal - 0 Blade shaft seal - 0
LOX Prevalve	1A49968-509	0124	Shaft seal - 0
LOX Chilldown Pump	1A49423-505	1763	Cavity seal - 0

4.2.27.1 (Continued)

Valve	P/N	S/N	Leakage (scim)
LH_2 Fill and Drain Valve	1A48240-505	0118	Main seal - 0 Blade shaft seal - 0
LH_2 Vent Valve	1A48257-511	0036	Combined main
LH_2 Relief Valve	1A49591-529	0132	Seal - 0
LH_2 Directional Control Valve	1A49988-1	0023	Shaft seal - 0
LH_2 Prevalve	1A49968-507	0022	Shaft seal - 0

Leakage:

Part	P/N	Location	Remedy
LOX Chilldown Pump	1A49423-505	Main static seal between tank and chilldown pump.	Per FARR A248632, new chilldown pump installed, and tank flange smoothed out.
LH_2 Fill and Drain Valve	1A48240-505	Outside of aft skirt.	New valve installed (Reference FARR A248642).

4.2.28 Range Safety System (1B66568 A)

The automatic checkout of the range safety system verified the system external/internal power transfer capability; and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command, and the system off command. The particular items involved in this test included the following:

Part Name	Ref. Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	104
Range Safety Receiver 2	411A97A18	50M10697	167
Secure Command Decoder 1	411A99A1	50M10698	92
Secure Command Decoder 2	411A99A2	50M10698	133
Secure Command Controller 1	411A97A13	1B33084-503	12
Secure Command Controller 2	411A97A19	1B33084-503	11
RS System 1 EBW Firing Unit	411A99A12	40M39515-119	463
RS System 2 EBW Firing Unit	411A99A20	40M39515-119	464
RS System 1 EBW Pulse Sensor	411A99A31	40M02852	*
RS System 2 EBW Pulse Sensor	411A99A32	40M02852	*
Safe and Arm Device	411A99A22	1A02446-503	*
Directional Power Divider	411A97A56	1B38999-1	20
Hybrid Power Divider	411A97A34	1A74778-501	47
* Installed in Pulse Sensor Assembly	-	1B29054-501	4

The procedure was accomplished on 17 March 1967, and was accepted on 21 March 1967. The first test run was terminated because of program problems, and because connectors 411W8P5 and 411W8P10 were cross-connected. These problems were resolved, and the second test run was satisfactory. The values measured during this second test run are presented in Test Data Table 4.2.28.1.

The stage power setup, H&CO 1B66560, was accomplished, and initial conditions were established for the test. The GSE Model DSV-4B-136 destruct system test set, P/N 1A59952-1, was set up for a -50 dbm output level at 450.000 $\pm$ 0.045 MHz. The forward bus 1 and bus 2 battery simulators were turned on, both range safety receivers were verified to be OFF, and the battery simulator voltages were measured.

4.2.28 (Continued)

An external/internal power transfer test was conducted next. Both EBW firing units were verified to be OFF, and the external power was turned on for the receiver and firing unit of both range safety systems. The charging voltage indications and the firing unit voltage indications were measured for both firing units. The cutoff command inhibit was turned on for both range safety receivers. Both firing units were transferred to internal power, the external power for these units was turned off, and both firing units were verified to be ON. The charging voltage indications were measured for both firing units. The firing units were both transferred back to external power and verified to be OFF, and the charging voltage indications were again measured. The external power for the receivers was then turned off, and both receivers were verified to be OFF. The receivers were then transferred to internal power and verified to be ON, then transferred back to external power and verified to be OFF. Finally, both receivers were transferred back to internal power, and again verified to be ON.

An EBW firing unit arm and engine cutoff test was conducted next. The engine control bus power was turned on, and the bus voltage was measured. The low level signal strength indications were measured for both receivers. The EBW firing unit arm and engine cutoff command was turned on, and verified to be received by range safety system 1. The system 1 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were OFF at the umbilical and through both the AO and BO telemetry multiplexers; that the non-programmed engine cutoff indication was OFF; and that the instrument unit receiver 1 arm and engine cutoff indi-

4.2.28 (Continued)

cation was OFF. The receiver 1 cutoff command inhibit was then turned off, and the instrument unit receiver 2 arm and engine cutoff indication was verified to be OFF. Verification was made that the engine control bus power was then OFF; that the engine cutoff indications were still OFF at the umbilical and through both multiplexers; that the non-programmed engine cutoff indication was still OFF; and that the instrument unit receiver 1 arm and engine cutoff indication was then ON. The receiver 1 cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff indication was verified to again be OFF. The EBW firing unit arm and engine cutoff command was turned off, and the engine control bus power was turned back on and verified to be 28.0 $\pm$ 2.0 vdc. Both firing units were transferred to external power and verified to be OFF, and the charging voltage indications were measured.

The EBW firing unit arm and engine cutoff command was turned back on, and verified to be received by range safety system 2. The system 2 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were OFF at the umbilical and through both the AO and BO telemetry multiplexers; that the non-programmed engine cutoff indication was OFF; and that the instrument unit receiver 2 arm and engine cutoff indication was OFF. The receiver 2 cutoff command inhibit was turned off, and the instrument unit receiver 1 arm and engine cutoff indication was verified to be OFF. Verification was made that the engine control bus power was still ON; that the engine cutoff indication was then ON at the umbilical and through both multiplexers; that the non-programmed engine cutoff indication was then ON; and that the instrument unit receiver 2 arm and engine cut-

4.2.28 (Continued)

off indication was ON. The receiver 2 cutoff command inhibit was turned back on, and the instrument unit receiver 2 arm and engine cutoff indication was verified to again be OFF. The EBW firing unit arm and engine cutoff command was turned off, the engine ready bypass was turned on, and the engine cutoff indication was verified to be OFF at the umbilical.

The EBW pulse sensor power and pulse sensor self test were turned on, and both range safety system pluse sensors were verified to be ON. The pulse sensor power was turned off and then back on, and both pulse sensors were verified to be OFF. The propellant dispersion command was turned on and verified to be received by the system 1 receiver. The system 1 firing unit charging voltage indication was measured, and the system 1 pulse sensor was verified to be OFF. The propellant dispersion command was turned off, the receiver 1 cutoff command inhibit was turned off, and the propellant dispersion command was turned back on. The system 1 firing unit charging voltage indication was measured, and the system 1 pulse sensor was verified to be ON. The cutoff command inhibit was turned back on, and the propellant dispersion command was turned off. The propellant dispersion command was then turned back on and verified to be received by the system 2 receiver. The above test was repeated on the system 2 firing unit and pulse sensor. After the test of system 2, the cutoff command inhibits were turned off for both receivers.

The range safety system off test was conducted next. The range safety system off command was turned on, and power for the system 1 receiver and EBW firing unit was verified to be OFF. The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system

4.2.28 (Continued)

off command was turned back on, and the power for the system 2 receiver and EBW firing unit was verified to be OFF. The range safety system off command was again turned off.

The final test was of the safe and arm device. The propellant dispersion safe-arm safe command was turned on, and it was verified that the safe indication was ON and the arm indication was OFF. The safe-arm arm command was turned on, and it was verified that the safe indication was OFF and the arm indication was ON. The safe-arm safe command was turned back on, and it was verified that the safe indication was again ON and the arm indication was again OFF. This completed the range safety system test. The computer printout indicated that the range safety receivers had a running time of 1 minute, 9.938 seconds during the last test run, and that the firing units had each been cycled one time.

Engineering comments noted the following parts shortages during this test, affecting only the initial conditions scan part of the test. The continuous vent module 411A32, P/N 1B67193-501, was not installed. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed per SEO 1A49590-513-018 in place of LOX vent and relief valve 424A1, P/N 1A48312-505. An interim use directional control valve, P/N 1A49988-1-002, was installed per SEO 1A49988-1-002 in place of directional control valve 411A29, P/N 1A49988-1.

As noted, the problems encountered during this test were with the program and mis-mated connectors. No failure and rejection reports were written during this procedure. Eighteen revisions were made to the procedure, with two of these being voided. One was voided because the change was documented against

4.2.28 (Continued)

the digital data tape, 1B66777, the other because it was superseded.

a. Five revisions corrected procedure and program errors to show that three relays were reset rather than set, to turn off a tone 5 command if a malfunction occurred, to set a malfunction flag to zero at a halt point, and to change the Hollerith field letter count for one print statement.

b. One revision added steps to transfer the EBW firing units to internal power during one back-up sequence, to re-establish the correct main-flow conditions.

c. One revision deleted seven steps that increased the accumulated cycle count on the EBW firing units, as the firing units were not cycled at those points.

d. One revision increased three time delays from 100 milliseconds to 270 milliseconds, to allow sufficient time for the pulse sensors to reset.

e. One revision deleted thirteen steps from a back-up sequence because they were not required.

f. One revision added the Model DSV-4B-238 propulsion system display unit, P/N 1A65732-1, to the Optional End Items list.

g. One revision added a statement to the Running Time/Cycle Record paragraph to note that the line printer would print out total running times at the completion of the test.

h. One revision added a step to set the output knob of the Model DSV-4B-136 destruct system test set for a reading of -50 on the dbm scale.

i. Two revisions deleted non-intervene codes from two program statements, as they were not required.

j. One revision deleted measurements involving the LH_2 continuous vent valve module from the initial conditions scan, as the valve was not installed.

k. One revision added a step to a back-up sequence to store a time reading only if the previously stored time was zero, to prevent losing a running time record.

4.2.28.1 Test Data Table, Range Safety System

Function	Measurement	Limits
Forward Bus 1 Battery Simulator (vdc)	28.199	28.0 ± 2.0
Forward Bus 2 Battery Simulator (vdc)	27.958	28.0 ± 2.0
External/Internal Power Transfer Test		
External Power On		
System 1 Charging Voltage Indication (vdc)	4.244	4.2 ± 0.3
System 1 Firing Unit Voltage Indication (vdc)	4.235	4.2 ± 0.3
System 2 Charging Voltage Indication (vdc)	4.270	4.2 ± 0.3
System 2 Firing Unit Voltage Indication (vdc)	4.261	4.2 ± 0.3
Internal Power		
System 1 Charging Voltage Indication (vdc)	4.244	4.2 ± 0.3
System 2 Charging Voltage Indication (vdc)	4.274	4.2 ± 0.3
External Power Off		
System 1 Charging Voltage Indication (vdc)	0.045	0.3 max.
System 2 Charging Voltage Indication (vdc)	0.045	0.3 max.
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage (vdc)	27.660	28.0 ± 2.0
Receiver 1 Signal Strength Indication (vdc)	3.563	3.75 ± 1.25
Receiver 2 Signal Strength Indication (vdc)	3.630	3.75 ± 1.25
System 1 Arm and Engine Cutoff Test		
System 1 Charging Voltage Indication (vdc)	4.244	4.2 ± 0.3
External Power Off		
System 1 Charging Voltage Indication (vdc)	0.050	0.3 max.
System 2 Charging Voltage Indication (vdc)	0.045	0.3 max.
System 2 Arm and Engine Cutoff Test		
System 2 Charging Voltage Indication (vdc)	4.274	4.2 ± 0.3
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off) (vdc)	4.249	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On) (vdc)	2.834	3.0 max.
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)(vdc)	4.284	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On) (vdc)	2.979	3.0 max.

4.2.29 Propulsion System Test (1B66572 B)

This automatic procedure performed the integrated electromechanical functional tests of the entire stage propulsion system. The procedure was divided into three sections, each of which was performed separately. The first section of the test procedure checked the pump purge pressure switches for activation, deactivation, and proper control functions. The first section also verified functional capability and valve operation of the pneumatic control system and the LOX and LH_2 repressurization systems. The second section of the procedure verified the operation of the LOX tank and LH_2 tank pressurization systems. The third section of the test was a four-part check of the J-2 engine spark ignition system, cutoff logic and delay timers, engine control helium bottle and valves, and engine operating sequence.

The procedure was started on 17 March 1967 and was completed and accepted on 4 April 1967 after six days of activity. Section 3, the J-2 engine system test, was completed first on 31 March 1967. Section 2, the propellant tanks pressurization system test, was run to completion next on 1 April 1967, and section 1, the ambient helium test was run last, also on 1 April 1967. The report of the procedures is presented with section 1 first and section 3 last, as they are described in the program. Measurements taken during the test are recorded in the Test Data Table 4.2.29.1.

4.2.29 (CONTINUED)

Section one, the ambient helium systems test, was completed on the first run on 1 April 1967. The stage functions dependent on the ambient helium system were the pneumatic control system, and the propellant tanks repressurization systems. For a helium transducer check, it was verified that the initial helium sphere pressure, as measured through the AO and BO multiplexers, was 700 ± 50 psia, and that the helium regulator discharge pressure was 515 ± 50 psia. The control helium dump valve and control module shutoff valve were functionally checked to begin the system test. This was followed by functional tests of the LOX chilldown pump purge pressure switch and the LH_2 and LOX tank repressurization control modules. LOX and LH_2 tank flight control pressure switch/repressurization interlock checks followed. The engine pump purge pressure switch and the control helium regulator pressure switch pickup and dropout pressures were measured. Switch selector command checks were conducted for applicable pneumatic valves, and a functional check of the continuous vent valve was conducted.

All pressure switch checks were repeated twice, with pickup and dropout pressure measurements made. The switch selector check consisted of commanding open the LOX and LH_2 vent valves, chilldown valves, and prevalves; then verifying that the commands had been followed. The valves were then commanded closed.

4.2.29 (CONTINUED)

Section two, the LOX and LH_2 tanks pressurization system test, was accomplished by the third test run on 1 April 1967. Computer malfunctions invalidated the first two runs. For the LOX tank pressure switch pickup and dropout check, the line and dome pressures, the pressure switch manifold pressurization and depressurization times, and the LOX ground fill pressure switch pickup and dropout pressures were measured.

The pressure switch pickup and dropout parts of the test were repeated twice, while measurements were made of the line and dome pressure, the manifold pressurization and depressurization times, and the LOX ground fill pressure switch pickup and dropout pressure and deadband pressure range. The ground fill pressure switch range was determined as the difference in pickup and dropout pressures.

The switch selector functions and the operation of the heat exchanger bypass valve were verified by measuring the LOX pressure module helium gas pressure and the cold helium control valve inlet pressure when the bypass valve was closed and opened respectively.

After the pressure switch tests were completed, the cold helium system was repressurized to 700 psia maximum, and the cold helium sphere pressure was measured. For the cold helium sphere blow-down and regulator test, the orifice, P/N 1B59462-1, was installed in the test adapter. The LOX pressure module helium gas pressure was verified to be greater than 370 psia. Repeated measurements were then made of the LOX helium gas pressure and the cold helium sphere pressure, until the sphere pressure dropped to 625.31 psia. After four measurements showed 625.31 psia, the cold helium supply shutoff

4.2.29 (CONTINUED)

valve was closed, completing the test.

The components of the LH_2 pressurization system were operated individually and the functional capability of each was verified. The parts tested included the LH_2 step pressure valve, the first burn bypass control valve, and the switch selector first and second burn relays.

Next, an LH_2 tank pressurization module interlock test was performed. The LH_2 step pressure and bypass control valves were verified when first and second burn commands were given. Ullage pressure in the tank was measured with the LH_2 prepressurization and both valves opened. The LH_2 first burn relay was then commanded closed. After a five-second delay, ullage pressure was then measured. The measured increase in ullage pressure indicated that the step pressure valve had closed. This was followed by the closing of the second burn relay, and by another five-second delay. Again, the measured increase in ullage pressure indicated that the bypass control valve had actuated.

For the LH_2 tank pressure switch check, measurements were made of the GSE stage 7 line and dome pressures, the manifold pressurization and depressurization times, and the flight control and ground fill over pressure pressure switch pickup and dropout pressures. Pressure switch deadband ranges were also determined. The switch selector was used 41 times during the test. Measured values are tabulated in the Test Data Table 4.2.29.1.

4.2.29 (CONTINUED)

Section 3, the J-2 engine system test, was divided into four sequences, each designed to test a specific engine operation. The spark ignition system check was first, followed by the mainstage OK pressure switches check. The control solenoid valves check was then conducted after which the engine sequence check was run. The J-2 engine system test was completed on 31 March 1967, on the third test run.

Operation of the detection system 1 and 2 engine cutoff commands was verified as well as the LH_2 and LOX vent valves, prevalves, and chilldown valves. The engine ignition bus voltage, the control bus voltage, and the component test power voltages were measured. The spark ignition systems 1 and 2 were checked, and the start tank pressure changes were verified for proper vent valve operation. Operating times of the engine ignition timer delay, the helium delay time, the spark deenergize timer, and the start tank discharge timer were measured. Engine cutoff commands were checked, and proper operation verified.

Mainstage OK pressure switches were checked, and measurements were made of the GSE stage 6 and stage 2 line and dome pressures. Operation of mainstage OK pressure switch 1 and 2 pickup and dropout pressures was verified. The pressure switch check was repeated twice. Measure and values are recorded in 4.2.29.1.

4.2.29 (CONTINUED)

The control solenoid valves check and the engine sequence check were then run twice. For the helium control solenoid valves check, the GSE stage 5 helium regulator was pressurized to 520 ± 30 psia, and the control helium supply sphere was pressurized to 1400 psia minimum. Operation was verified and measurements taken, where tolerances were involved, of the helium control solenoid valve, the LOX and LH_2 bleed valves and main valves, the start tank discharge valve, the gas generator valve, the LOX turbine bypass valve, and the ASI LOX valve.

For the engine sequence check, the engine ignition bus power was turned on, the entire engine system was verified to be ready for the check, and the component test power was turned on. The engine sequence check was a completely automatic repetition of previous parts of the engine system test, where the necessary commands were given to cause engine start and engine cutoff, and the system responses to the commands were verified to be within the predetermined limits. Various operating times were measured during the sequence to verify the proper operation of the system component items.

Engineering comments indicated that the following parts were not installed at the start of testing.

P/N	NAME
1B66692-1	Actuation Control Module, seven locations.
1B67193-501F	Control Vent Module
1A48312-505	LOX Vent and Relief Valve
1A49988-1	Directional Control Valve

The following interim use materials (IUM) were installed in lieu of the parts not installed.

P/N	NAME
1B65292-501	Actuation Control Module, seven locations, per SEO 1B65292-501-005 and 009.
1B51753-501-007	Control Vent Valve
1A49590-513-018	LOX Vent and Relief Valve, per SEO 1A49590-513-018.

4.2.29 (CONTINUED)

Twenty-five revisions were written: one was voided, one corrected a typing error, one deleted a step that was not required, and two corrected program errors. Variations and procedural changes were as follows:

a. One revision corrected the tolerance on the power supply voltage.

b. One revision corrected a malfunction caused by the incorrect value in a time cell. Nine time cell changes were authorized by this revision because of the program error.

c. One revision deleted a step and detailed the manual procedure to verify control helium regulator backup pressure switch, P/N 1B52624-517, S/N 010. Pickup pressures of 611 psia and dropout pressures of 490 psia were given for three cycles.

d. One revision changed the LOX pressure module helium gas pressure minimum from 100 to 75 psia.

e. One revision, by deleting two steps, revised the LOX pressure module helium gas pressure maximum from 425 to 430 psia to allow for a 2 per cent system tolerance.

f. One revision changed the step pressure differential from 20 to 10 psia, since 10 psia is adequate to verify valve actuation.

g. Two revisions specified delays of two and four seconds, respectively, until the LOX pre-valve and the LOX and LH_2 chilldown shutoff valves were opened, since valve motion was inhibited by the flex hose on the actuator.

h. One revision defined the prevalve ground supply port statement number, since the connection was needed only in the engine sequence test.

i. One revision provided the break point required to reset the GSE cut-off lock-in manually, since the breakpoint was out of sequence at a later step.

j. One revision increased the stage 4 pressure in the J2 engine system test from 1400 to 1450 $\pm$ 50 psia.

k. One revision changed the procedure to provide for measuring the voltage at the power supply.

4.2.29 (CONTINUED)

l. One revision varied the stage 2 line pressure from 175 ± 25 to 175 + 25 -26, since, on the first cycle, this stage was loaded to 149 psia, which is adequate for pressure switch testing.

m. One revision readjusted the power supply to establish initial conditions.

n. Two revisions deleted oscillograph use because spark parameters from the engine were not patched in.

o. One revision added an operation to the ambient helium systems checkout procedure, verifying that propellant repressurization lines were connected to the pneumatic system should the tests be run out of sequence.

p. Two revisions deleted steps to correct malfunctions. Engineering review of oscillograph data showed LOX poppet motion start and travel time to be within the specified tolerances.

4.2.29.1 Test Table Data - Propulsion System Test

Section 1, Ambient Helium Test

LOX Chilldown Pump Purge Pressure Switch Test

Function	Measured Value (psia) Test 1	Test 2	Test 3	Limits
Stage 8 Line Pressure	46.0	47.0	47.0	50 ± 5
Stage 8 Dome Pressure	50.0	49.0	49.0	-
Pump PS In(sec)	90.439	87.399	78.819	-
Pump Purge PS Pickup	40.28	40.23	40.13	-
PS Depress. (sec)	21.674	11.343	12.052	-
Pump Purge PS Dropout	38.98	38.98	38.98	-
Pump Purge PS Deadband	1.30	1.25	1.14	-

Engine Pump Purge PS Test

Function	Measured Value (psia) Test 1	Test 2	Test 3	Limits
Stage 2 Line Pressure	141.0	164.0	156.0	175 ± 25
Stage 2 Dome Pressure	197.0	197.0	205.0	-
Pump Purge PS Pickup	119.17	119.17	117.88	-
Pump Purge PS Dropout	107.53	108.82	108.82	-
Pump Purge PS Deadband	11.64	10.35	9.05	-

Control Helium Backup Pressure Switch Check

Function	Measured Value (psia) Test 1	Test 2	Test 3	Limits
Stage 2 Line Pressure	695.03	659.03	651.59	650 ± 25
Stage 2 Dome Pressure	692.53	685.09	692.53	-
He. Reg. Backup Press.(sec)	26.543	26.395	26.394	-
Backup PS Sys. Depress.(sec)	6.180	0.157	6.169	-
He Reg. Backup PS Dropout	507.06	507.71	506.42	-
He. Reg. Backup PS Pickup	-	-	620.203	-

4.2.29.1 (CONTINUED)

Pneumatic Control System Test

Operating Times (sec)

Function	Open	Total Open	Close	Total Close	Boost	Total Boost
LH_2 Vent Valve	0.021	0.115	0.192	0.370	0.085	0.187
LOX Vent Valve	0.017	0.107	0.136	0.323	0.077	0.207
LOX Fill and Drain Valve	0.143	0.291	0.787	2.321	0.447	0.964
LH_2 Fill and Drain Valve	0.110	0.247	0.725	1.992	0.351	0.846
LOX Prevalve	1.538	2.104	0.261	0.428	-	-
LH_2 Prevalve	1.364	2.008	0.254	0.419	-	-
LOX CD Shutoff	0.285	0.964	0.022	0.159	-	-
LH_2 CD Shutoff	0.244	0.882	0.023	0.160	-	-

Function	Measured Value (psia)	Limits
Control Helium Sphere Press.	701.09	700 ± 50
Control Helium Reg. Discharge Press.	554.66	515 ± 50

Position

Function	Flight	Total Flight	Ground	Total Ground
LH_2 Directional	0.058	0.198	0.223	0.400

Section 2, Propellant Tanks Pressurization Switch Test

Pressure Switch Test

Measured Value (psia)

Function	Test 1	Test 2	Test 3	Limits
Stage 2 Line Press	555.0	559.0	554.0	550 ± 25
Stage 2 Dome Press.	596.0	603.0	592.0	-
Cold He. PS Pickup Press.	486.381	485.078	485.078	467.5±23.5
Cold He. PS Dropout Press.	387.0	387.0	388.0	362.5±33.5
Control He. PS Pickup Press.	611.0	611.0	611.0	600 ± 15
Control He. PS Dropout Press.	490.0	490.0	490.0	490 ± 25

4.2.29.1 (CONTINUED)

Propellant Tanks Pressurization Switch Test (Continued)

LOX Tank Pressure Switch Check

Function	Measured Value Test 1	Test 2	Test 3	Limits
Stage 8 Line Press. (psia)	47.23	46.81	46.81	50 ± 5
Stage 8 Dome Press. (psia)	50.21	49.36	49.36	-
Manifold Press. Time (sec.)	89.712	76.271	76.915	-
Manifold Depress. Time (sec.)	13.917	12.940	12.720	-
Ground Fill PS Pickup (psia)	40.13	40.07	40.07	41.0 max.
Ground Fill PS Dropout (psia)	38.73	38.62	38.67	36.5 min.
Ground Fill PS Range (psia)	1.40	1.45	1.40	0.5 min.

Heat Exchanger Bypass Valve Check

Function	Bypass Closed (psia)	Bypass Open (psia)
LOX Press. Module He. Gas Press.	180.44	91.51
Cold He. Control Valve Inlet	166.25	61.51

LH_2 Tank Pressure Switch Check

Function	Measured Value Test 1	Test 2	Test 3	Limits
Stage 7 Line Press. (psia)	47.55	47.55	47.87	50 ± 5
Stage 7 Dome Press. (psia)	52.34	51.70	51.38	-
Manifold Press. Time (sec.)	72.203	52.109	51.496	-
Manifold Depress. Time (sec.)	131.243	129.708	131.293	-
Flight Control PS Pickup (psia)	30.46	30.25	30.25	31.5 max.
Flight Control PS Dropout (psia)	27.89	27.89	27.94	27.8 min.
Flight Control PS Deadband (psia)	2.57	2.37	2.31	0.5 min.
Gnd. Fill Overpress. PS Pickup (psia)	33.70	33.55	33.60	34.0 max.
Gnd. Fill Overpress. PS Dropout (psia)	31.49	31.59	31.49	30.8 min.
Gnd. Fill Overpress. PS Deadband (psia)	2.21	1.96	2.11	0.5 min.

Valve Functional Check

	GH_2 Press. (psia)	Limits (psia)
Valves Open (A)	60.83	-
Step Press. Valve Closed by 1st Burn Relay ON (B)	75.01	At least (A) + 10
Bypass Control Valve Closed by 2nd Burn Relay ON (C)	112.11	At least (B) + 20

4.2.29.1 (CONTINUED)

Section 3, J-2 Engine System Test

Function	Measured Value	Limits
Engine Ignition Bus Voltage	27.75 vdc	27 ± 3 vdc
Engine Control Bus Voltage	27.75 vdc	27 ± 3 vdc
Component Test Power Voltage	27.80 vdc	27 ± 3 vdc
Start Tank Pressure	83.86 psia	40 psia min.
Engine Ignition Timer Delay	0.450 sec.	0.45 ± 0.03 sec.
Helium Delay Timer	0.995 sec.	1.0 ± 0.11 sec.
Sparks Deenergize Timer	3.300 sec.	3.3 ± 0.20 sec.
Start Tank Discharge Timer	1.006 sec.	1.00 ± 0.04 sec.

Mainstage OK Pressure Switches Check

Function	Measured Value (psia) Test 1	Test 2	Test 3	Limits (psia)
Stage 6 Line Pressure	571.25	567.00	568.06	600 ± 50
Stage 6 Dome Pressure	589.34	584.02	585.09	
Mainstage OK PS 1 Pickup	497.77	495.27	495.27	515 ± 36
Mainstage OK PS 1 Dropout	427.57	426.95	426.32	PU-62.5 ± 43.5
Stage 2 Line Pressure	573.39	580.83	584.56	600 ± 50
Stage 2 Dome Pressure	603.17	610.63	610.63	
Mainstage OK PS 2 Pickup	534.86	530.98	529.69	515 ± 36
Mainstage OK PS 2 Dropout	455.34	457.29	455.34	PU-62.5 ± 43.5

Control Solenoid Valves Check	Regulator Output Press. (psia) Run 1	Run 2	Limit
AO Multiplexer	416.08	418.38	440 max.
BO Multiplexer	415.31	415.31	

4.2.29.1 (CONTINUED)

Control Solenoid Valves Check (Continued)

Function	Measured Position (%)		
	Run 1	Run 2	Limit (%)
Main LH_2 Valve Closed	10.40	10.10	10 ± 10
Main LH_2 Valve Open	88.80	88.70	90 ± 10
Main LH_2 Valve Reclosed	10.20	10.10	Closed ± 2
Start Tank Disch. Valve Closed	10.60	10.70	10 ± 10
Start Tank Disch. Valve Open	92.00	92.20	90 ± 10
Start Tank Disch. Valve Reclosed	10.50	10.70	Closed ± 2
Gas Generator Valve Closed	6.80	7.20	10 ± 10
Gas Generator Valve Open	84.40	84.50	90 ± 10
Gas Generator Valve Plateau	45.10	44.69	65 max.
Gas Generator Valve Reclosed	7.20	7.40	Closed ± 2
Main LOX Valve Closed	10.10	10.20	10 ± 10
Main LOX Vent 1st Ramp	22.80	22.80	-
Main LOX Valve Open	89.60	89.30	90 ± 10
Main LOX Valve Reclosed	10.30	10.10	Closed ± 2
LOX Turbine Bypass Valve Open	89.20	89.00	90 ± 10
LOX Turbine Bypass Valve Closed	7.00	6.80	10 ± 10
LOX Turbine Bypass Valve Reopened	89.00	89.00	Open ± 2

Engine Sequence Check

Function	Run 1 Time (sec)			Run 2 Time (sec)		
	Start	Oper.	Total	Start	Oper.	Total
Ignition Phase Solenoid Talkback	-	0.017	-	-	0.014	-
Control He. Solenoid Talkback	-	0.023	-	-	0.020	-
ASI LOX Valve Open	-	0.036	-	-	0.030	-
Main LH_2 Valve Open	0.062	0.063	0.124	0.054	0.074	0.128
LOX Bleed Valve Closed	-	0.086	-	-	0.074	-
LH_2 Bleed Valve Closed	-	0.059	-	-	0.103	-
Start Tank Disch. Timer	-	1.010	-	-	1.007	-
Start Tank Disch. Valve Open	0.090	0.104	0.194	0.094	0.104	0.198
Mainstage Control Solenoid Energ.	-	1.457	-	-	1.457	-
Ignition Phase Timer	-	0.447	-	-	0.450	-
Start Tank Disch. Control Sol. Off	-	0.007	-	-	0.007	-
Main LOX Valve 1st Stage Motion	0.060	0.034	0.094	0.060	0.037	0.97
Start Tank Disch. Valve Closed	0.085	0.253	0.338	0.088	0.249	0.337

4.2.29.1 (CONTINUED)

Engine Sequence Check (CONTINUED)

Function	Run 1 Time (sec) Start	Oper.	Total	Run 2 Time (sec) Start	Oper.	Total
Gas Gen. Valve LOX Poppet	0.130	0.056	0.186	0.197	0.063	0.188
LOX Turbine Bypass Valve Close	0.202	0.251	0.453	0.197	0.258	0.455
Main LOX Valve 2nd Stage Motion	0.656	1.830	2.486	0.647	1.842	2.489
Spark System Off Timer	-	3.300	-	-	3.300	-
Ignition Phase Control Solenoid Off	-	0.007	-	-	0.007	-
Mainstage Control Solenoid-Off		0.034	-	-	0.034	-
ASI LOX Valve Closed	0.028	0.419	-	0.028	-	-
Main LOX Valve Closed	0.058	0.119	0.177	0.058	0.119	0.177
Main LH_2 Valve Closed	0.088	0.222	0.310	0.090	0.226	0.315
Gas Generator Valve Closed	0.066	0.252	0.318	0.066	0.266	0.332
Gas Generator Valve LOX Poppet Closed	0.132	-	-	0.032	-	-
LOX Turbine Bypass Valve Open	0.265	0.747	1.012	0.262	0.749	1.011
Control He. Solenoid De-energ. Timer	-	1.00	-	-	0.999	-
LOX Bleed Valve Open	11.851	-	-	11.903	-	-
LH_2 Bleed Valve Open	11.593	-	-	11.677	-	-

4.2.30 Hydraulic System Fill, Flush, Bleed and Fluid Samples (1B40973 C)

The purpose of this procedure was to ensure that the hydraulic system was correctly filled, flushed, bled, and maintained free of contaminants during hydraulic system operation. The hydraulic pressure and temperature were checked for proper operational levels, the hydraulic system transducers were tested for proper operation, and engine operational clearance in the aft skirt was established.

This test procedure was initiated on 20 March 1967, continued on 22 March 1967, and was completed on 12 April 1967. Acceptance was made on 13 April 1967. During the 3 days of activity, proper operation of the auxiliary hydraulic pump, P/N 1A66241-507, S/N X454664; the hydraulic actuator assemblies, P/N 1A66248-505-011, S/N's 52 and 63; the main pump, P/N 1A86847-509, S/N 050; and accumulator/reservoir assembly, P/N 1B29319-519, S/N 00026, were verified. There were no parts shortages affecting this test.

Before initiation of the test, the hydraulic pumping unit (HPU), P/N 1A67443-1, Model DSV-4B-358 was checked to ensure hydraulic fluid cleanliness. The HPU was then connected to the stage via the pressure and return hoses. Hydraulic fluid was then circulated through the stage hydraulic system to ensure that the system was properly filled, and that the hydraulic fluid passed the cleanliness requirements. Initial electrical stage power setup conditions H&CO 1B66560 were performed to enable a transducer readout of the reservoir when full and empty. This was to further ensure hydraulic system cleanliness and fullness, by cycling the reservoir piston.

4.2.30 (Continued)

During the accumulator/reservoir fill and flush portion of the test, a check was made of the accumulator/reservoir low pressure and high pressure relief valves. These measurements are shown in Test Data Table 4.2.30.1.

The accumulator precharge high pressure and relief valve check was performed next. An outside air temperature of 64°F required a precharge pressure of 2325 psig on the accumulator. The accumulator was charged to this pressure, then the system was checked for internal leakage, high pressure relief valve cracking pressure, reservoir pressure, differential pressure, high pressure relief valve reseat pressure, reservoir pressure, and differential pressure. (Differential pressure is the difference of the reservoir pressure from the system pressure.) These measurements are shown in Test Data Table 4.2.30.1.

After connecting the gimbal control unit, P/N 1B50915-1, Model DSV-4B-699, the complete system flush was performed. The gimbal control unit was used to slowly slew the engine in two square patterns to the extreme of the actuator travel, while checking complete engine installation for clearance and freedom of motion.

An air content test was performed to ensure that there was a minimum of air in the system; then the hydraulic pressure, temperature, and position transducer operation was performed. The midstroke mechanical locks were installed and the gimbal control unit was disconnected. The initial electrical conditions were set up per the stage power setup drawing, then, with the accumulator precharged and the auxiliary hydraulic pump/motor off, the measurements in Test Data Table 4.2.30.1 were obtained. The auxiliary hydraulic pump/motor was switched on and run for 1 minute, to obtain measurements.

4.2.30 (Continued)

This test procedure was used throughout the hydraulic system operation to monitor and maintain the hydraulic system in an acceptable condition.

According to IIS 334598, six pipes had leakage at "B" nut connections. The pipes were P/N's 1B32333-1, 1B32329-1, 1B32334-1, 1B32335-1, 1B32330-1, and 1B32326-1. Altogether, ten leakage areas were involved. Each of these conditions was resolved by retorquing the loose "B" nuts.

The following twenty-three revisions were described in the revision documentation log sheet:

a. Two revisions specified connecting hoses before pressurizing the system, as it is difficult to install hoses under pressure.

b. One specified more detailed instructions for obtaining readings from a voltmeter when the auxiliary hydraulic pump was turned on.

c. A revision was necessary to correct the callout of the Stage Power Setup.

d. One called for the auxiliary hydraulic pump to be charged after the accumulator, rather than before.

e. Another deleted a callout to close the HPU bypass valve during the relief valve check, as it had already been closed.

f. One revision deleted the provision to turn on the HPU high pressure pump during the relief valve check, as this had previously been done.

g. The requirement to open the HPU bypass valve after checking the reservoir oil level was deleted, as this was unnecessary.

h. A revision specified the cables to be disconnected from the servo valve during the gimbal control unit hookup and calibration. The specific cables involved had not been noted in the text of the procedure.

i. The tenth revision, also written during the gimbal control unit calibration, called for setting the auto mode switch to position 2, rather than position 1. This was necessary because the needle would not oscillate in position 1.

4.2.30 (Continued)

j. A revision specified that, before the auxiliary pump motor was switched on, Aft Bus 2 had to be turned on. After the motor was on, personnel were to verify by audible means that the pump was operating.

k. Another revision noted that Aft Bus 2 was to be turned off before the pump motor was switched off. Again, personnel were to listen to verify that the pump was no longer running.

l. One revision deleted the requirement for charging the air bottle prior to turning on the pump motor, as this had already been accomplished.

m. Per one revision, the requirement to record the pressure gage indication on the jumper hose was incorporated in the step pertaining to recording flow indication.

n. A revision specified the means of finding reservoir pressure during the pressure test.

o. Another provided for waiting for pressure to decay, before the prefiltration valves were moved to the bypass position during the air content test.

p. An error in a paragraph callout was corrected per one revision.

q. One revision provided for R/NAA removal of the engine links and struts prior to the removal of the gimbal control unit cables from the actuators.

r. A revision specified turning on the HPU high pressure pump before the bypass valve was closed, as this was necessary to build up pressure.

s. The twentieth revision noted that the HPU pressure compensator should have been adjusted to 2000 $\pm$ 100 psig, rather than 3650 $\pm$ 100 psig, as the Model 699 gimbal control unit had not been reworked.

t. The next revision deleted the specification of the actuator cycle amplitude, as this was not necessary.

u. A revision modified the sampling procedure, to reflect the redesigned actuator fixture.

v. The final revision deleted the requirement to disconnect the auxiliary pump motor cable during system shutdown, as this was not required.

4.2.30.1 Test Data Table, Hydraulic System Fill, Flush, Bleed, and Fluid Samples

Low Pressure Relief Valve

TEST DESCRIPTION	RECORD	REQUIREMENT
Low Pressure Relief Valve Relief Pressure (Ground Return)	255 psig	275 ± 25 psig
Low Pressure Relief Valve Reseat Pressure (Ground Return)	227 psig	220 psig min.
Low Pressure Relief Valve Relief Pressure (Overboard)	275 psig	275 ± 25 psig
Low Pressure Relief Valve Reseat (Overboard)	255 psig	220 psig min.
High Pressure Relief Valve Flow Check:		
System Hydraulic Pressure High	4300 psig	4400 psig max.
Return Pressure	260 psig	-
Differential Pressure	4040 psia	3900 psia min.

High Pressure Relief Valve

TEST DESCRIPTION	RECORD	REQUIREMENT
System Internal Leakage	0.6 GPM	Less than 0.8 GPM
High Pressure Relief Valve Cracking Pressure	4300 psig	-
Reservoir Pressure	260 psig	-
Differential Pressure	4040 psi	4100 max.
High Pressure Relief Valve Reseat Pressure	4175 psig	-
Reservoir Pressure	255 psig	-
Differential Pressure	3920 psi	3760 min.

4.2.30.1 (Continued)

Auxiliary Hydraulic Pump/Motor Off

Measurement Name	Record Measurements	Measurement Limits
5V Aft Excitation Module Voltage	5.00	5 ± 0.05 vdc
Hydraulic System Pressure	1372	Approximately 1400 psi
Hydraulic Pump Inlet Oil Temperature	76.1	Approximately Ambient Temp.
Reservoir Oil Pressure	73.8	Approximately 80 psi - Must be greater than 55 psi
GN_2 Accumulator Pressure	2348	Precharge Pressure Approximately 2350 psia
GN_2 Accumulator Temperature	77.6	Approximately Ambient Temperature
Reservoir Oil Level	94.3	Greater than 84.7 Percent
Reservoir Oil Temperature	86.3	Approximately Ambient Temperature

Auxiliary Hydraulic Pump/Motor On

Measurement Name	Record Measurements	Measurement Limits
5V Aft Excitation Module Voltage	5.00	5 ± 0.05 vdc
Hydraulic System Pressure	3614	3650 ± 150 psi
Hydraulic Pump Inlet Oil Temperature	84.7	Approximately Ambient Temperature. Temperature will climb as running time increases
Reservoir Oil Pressure	172.4	180 ± 20 psia

4.2.30.1 (Continued)

Measurement Name	Record Measurements	Measurement Limits
GN_2 Accumulator Pressure	3578	Hydraulic System Pressure ± 100 psi
GN_2 Accumulator Temperature	86.6	Approximately Ambient Temperature. Temperature will climb as running time increases
Reservoir Oil Level	39.4	Greater than 25 per cent - Should read approximately 43 per cent
Reservoir Oil Temperature	90.2	Approximately Ambient Temperature - Temperature will climb as running time increases
T.M. Pitch Actuator Piston Pot Position	-0.002	± 0.236 degrees
T.M Yaw Actuator Piston Pot Position	-0.004	± 0.236 degrees

4.2.31 Hydraulic System (1B66570 A)

This automatic procedure verified the integrity of the stage hydraulic system, and demonstrated the capability of the system to provide engine centering and control during powered flight. The test involved all components of the stage hydraulic system, including the hydraulic pump, P/N 1A86847-509, S/N 50; the auxiliary hydraulic pump, P/N 1A66241-507, S/N X454664; the accumulator/reservoir assembly, P/N 1B29319-519, S/N 26; the hydraulic pitch actuator 403A71A1, P/N 1A66248-505-011, S/N 52; and the hydraulic yaw actuator 403A72L1, P/N 1A66248-505-011, S/N 63.

The procedure was satisfactorily accomplished by the first test run on 23 March 1967, and was accepted on 30 March 1967. Those function values measured during the test are presented in Test Data Table 4.2.31.1. All of these values were acceptable and were within general design requirements, although specific limit requirements were not defined in the procedure for most of the measurements.

The stage power setup, H&CO 1B66560, was accomplished, and initial conditions were established for the test. The instrument unit (IU) 5 volt power supply was turned on and its voltage was measured, and the aft 5 volt excitation module voltage was measured. Measurements were made of various hydraulic system functions with the hydraulic system unpressurized. Measurements were also made to determine the accumulator/reservoir gaseous nitrogen mass and corrected oil level.

The methods of turning on the auxiliary hydraulic pump were checked next. During these checks, the aft bus 2 power was not turned on, so the pump itself did not actually turn on. Only the auxiliary pump ON indication was

4.2.31 (Continued)

checked. The coast mode operation was checked by applying dry ice to the coast mode thermal switch and verifying that the low temperature caused the thermal switch to turn the auxiliary pump ON when the auxiliary hydraulic pump coast command was turned on, and that turning off the coast command turned the auxiliary pump OFF. The flight mode operation was checked by verifying that turning the auxiliary hydraulic pump flight command on and off properly turned the auxiliary pump ON and OFF. The manual mode operation was checked by verifying that the auxiliary pump could be properly turned ON and OFF at the GSE mechanical systems panel when the GSE was in the manual mode.

A sine wave generator test was satisfactorily conducted to verify proper operation of the generator. The engine centering tests were then conducted. The first test was conducted with the actuator position locks on and with the hydraulic system unpressurized. By measuring the actuator positions, and the voltage of the IU substitute 5 volt power supply and the aft 5 volt excitation module, the corrected actuator positions were determined. The pitch and yaw actuator locks were then removed, and the aft bus 2 power was turned on and the voltage was measured. The auxiliary hydraulic pump was turned on in the automatic mode, and the aft bus 2 current was measured. The hydraulic system pressure was measured, and the various hydraulic system functions were verified to be within their proper operating limits.

With the hydraulic system pressurized, the second engine centering test was conducted with the actuator locks off and with no excitation signal applied to the actuators. By repeating the test measurements as before, the corrected actuator positions were again determined. A zero excitation signal was then applied to the actuators, and the hydraulic system functions were measured.

4.2.31 (Continued)

A clearance, linearity, and polarity check was accomplished next. The actuators were individually extended to their stops and then retracted, causing the engine to move out to its extremes of travel, 0 degrees to 7 1/2 degrees, in a square pattern, counterclockwise as viewed from the engine bell. The engine was then returned to its 0 degree centered position. As the engine was sequenced through the square pattern, a clearance check verified that there was no interference to engine motion within the gimbal envelope. A comparison of the hydraulic servo engine positioning system command and response signals verified that the response movement was of the correct polarity and magnitude to agree with the command signal, and met the requirements for movement linearity.

Transient response tests were conducted next. Step commands were separately applied to the pitch and yaw actuators, causing each actuator to individually move the engine from 0 degrees to -3 degrees, from -3 degrees to 0 degrees, from 0 degrees to +3 degrees, and from +3 degrees to 0 degrees. The engine response was observed visually and audibly for unwanted oscillations, and the actuator responses were recorded during the engine movement. The engine slew rates were manually calculated for each of the step movements. The Test Data Table shows the calculated slew rates and representative actuator response values for the initial period of each check. The values measured were all acceptable and within general design requirements, although specific limits were not discernible from the procedure.

After the transient response test was completed, final measurements were made of the hydraulic system functions and the engine centering functions with the hydraulic system pressurized, the actuator locks off, and no excitation signals applied to the actuators.

4.2.31 (Continued)

The procedure was completed by turning off the auxiliary hydraulic pump, aft bus 2, and the IU substitute 5 volt power supply. The pitch and yaw actuator locks were then replaced. The computer printout noted that during this procedure the switch selector was cycled 24 times; the auxiliary hydraulic pump accumulated 1 cycle and 19 minutes, 59.890 seconds of running time; and the engine accumulated 1.5 cycles of 7.5 degrees amplitude and 1 cycle of 3 degrees amplitude in the pitch plane, and 1 cycle at each amplitude in the yaw plane.

Engineering comments noted several parts shortages that affected only the initial conditions scan part of the test. The LOX chilldown pump 424A4, P/N 1A49423-505, and the LOX chilldown shutoff valve 424A4, P/N 1A49965-517, were not installed. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed per SEO 1A49590-513-018 in place of LOX vent and relief valve 424A1, P/N 1A48312-505. An interim use continuous vent module, P/N 1B51753-501-007, was installed per SEO 1B67193-004 in place of continuous vent module 411A32, P/N 1B67193-501.

No major problems were encountered during this procedure, and no failure and rejection reports were written. A program error caused the computer to print out incorrect engine slew rate values for the 3 degree transient response test, and an engineering comment was written to provide the manually calculated correct slew rates, as shown in the Test Data Table.

Four revisions were made to the procedure for the following:

a. One revision changed an "if" statement to verify that the hydraulic pump inlet oil temperature (C50PIT), rather than the hydraulic reservoir oil temperature (C51ROT), met the required condition during the initial check of the pressurized hydraulic system, to agree with test requirements drawing 1B40171.

4.2.31 (Continued)

b. One revision changed the memory location referenced in three statements of the shutdown part of the procedure, to obtain the correct running time for the auxiliary hydraulic pump.

c. Two revisions deleted functions of the LH_2 continuous vent valve and the LOX chilldown shutoff valve from the initial conditions scan, as these items were not installed. The cable to the LOX chilldown shutoff valve was also disconnected because of repair work being performed.

4.2.31.1 Test Data Table, Hydraulic System

Function	Measurement	Limits
IU Substitute 5 volt Power Supply (vdc)	5.00	5.00 ± 0.05
Aft 5 volt Excitation Module (vdc)	5.00	5.00 ± 0.05
Hydraulic System Unpressurized		
Reservoir Oil Pressure (psia)	72.88	*
Accumulator GN_2 Pressure (psia)	2222.81	*
Accumulator GN_2 Temperature (°F)	73.70	*
Reservoir Oil Level (%)	92.56	*
Pump Inlet Oil Temperature (°F)	76.84	*
Reservoir Oil Temperature (°F)	74.49	*
Aft Bus 2 Current (amp)	0.00	*
Gaseous Nitrogen Mass (lb)	1.802	1.925 ± 0.2
Corrected Reservoir Oil Level (%)	99.9	95.0 min.
Engine Centering Test, Locks On, System Unpressurized		
T/M Pitch Actuator Position (deg)	-0.03	*
IU Pitch Actuator Position (deg)	-0.06	*
T/M Yaw Actuator Position (deg)	-0.03	*
IU Yaw Actuator Position (deg)	0.00	*
IU Substitute 5 volt Power Supply (vdc)	4.99	*
Aft 5 volt Excitation Module (vdc)	5.00	*
Corrected T/M Pitch Actuator Position (deg)	-0.025	-0.236 to 0.236
Corrected IU Pitch Actuator Position (deg)	-0.066	-0.236 to 0.236
Corrected T/M Yaw Actuator Position (deg)	-0.036	-0.236 to 0.236
Corrected IU Yaw Actuator Position (deg)	0.007	-0.236 to 0.236
Aft Bus 2 Voltage (vdc)	56.24	56.0 ± 4.0
Aft Bus 2 Current (amp)	54.40	55.0 ± 30.0
Hydraulic System Pressure (psia)	261.9	200.0 min.

* Limits Not Specified

4.2.31.1 (Continued)

Function	Measurement	Limits
Engine Centering Test, Locks Off, System Pressurized, No Excitation Signal		
T/M Pitch Actuator Position (deg)	-0.05	*
IU Pitch Actuator Position (deg)	-0.06	*
T/M Yaw Actuator Position (deg)	-0.04	*
IU Yaw Actuator Position (deg)	-0.03	*
IU Substitute 5 volt Power Supply (vdc)	4.99	*
Aft 5 volt Excitation Module (vdc)	5.00	*
Corrected T/M Pitch Actuator Position (deg)	-0.041	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.066	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	-0.053	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	-0.022	-0.517 to 0.517
Hydraulic System Pressurized, Locks Off, Zero Excitation Signal Applied to Actuators		
Hydraulic System Pressure (psia)	3604.63	*
Reservoir Oil Pressure (psia)	166.71	*
Accumulator GN_2 Pressure (psia)	3586.69	*
Accumulator GN_2 Temperature (°F)	94.89	*
Reservoir Oil Level (%)	35.66	*
Pump Inlet Oil Temperature (°F)	72.14	*
Reservoir Oil Temperature (°F)	77.23	*
Aft Bus 2 Current (amp)	42.20	*

Pitch 0 to -3 Degree Step Response - Engine Slew Rate: 15.6 deg/sec

Time from Start (seconds)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	- 0.100	-0.104	4.999
0.027	-19.971	-0.533	4.990
0.056	-19.971	-0.895	4.990
0.083	-19.971	-1.327	4.990
0.111	-19.971	-1.789	4.990
0.140	-19.971	-2.236	4.990
0.167	-19.971	-2.626	5.000
0.195	-20.020	-2.856	5.000
0.224	-19.971	-3.001	4.990
0.251	-19.971	-3.059	4.990
0.279	-19.971	-3.116	4.990
0.308	-19.971	-3.159	4.990

* Limits Not Specified

4.2.31.1 (Continued)

Pitch -3 to 0 Degree Step Response - Engine Slew Rate: 15.1 deg/sec

Time from Start (seconds)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	-19.949	-3.209	4.999
0.026	- 0.146	-2.727	5.000
0.055	- 0.146	-2.322	5.000
0.082	- 0.098	-1.962	4.990
0.110	- 0.146	-1.515	4.990
0.139	- 0.146	-1.067	5.000
0.166	- 0.146	-0.692	5.000
0.195	- 0.146	-0.360	4.990
0.224	- 0.146	-0.173	4.985
0.250	- 0.146	-0.101	4.990
0.278	- 0.098	-0.101	4.990
0.307	0.000	-0.129	4.990

Pitch 0 to +3 Degree Step Response - Engine Slew Rate: 14.6 deg/sec

Time from Start (seconds)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	- 0.100	-0.074	4.994
0.025	19.873	0.347	5.000
0.054	19.824	0.736	5.000
0.082	19.873	1.126	4.990
0.109	19.873	1.559	4.990
0.138	19.824	2.006	4.990
0.167	19.824	2.410	4.990
0.194	19.873	2.713	4.990
0.223	19.873	2.915	5.000
0.251	19.824	2.973	4.990
0.277	19.824	2.987	5.000
0.306	19.873	2.987	5.000

Pitch +3 to 0 Degree Step Response - Engine Slew Rate: 15.3 deg/sec

Time from Start (seconds)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	19.850	3.060	4.994
0.026	- 0.146	2.598	4.990
0.055	- 0.146	2.208	4.990
0.082	- 0.098	1.775	4.990
0.110	- 0.098	1.313	4.990
0.139	0.000	0.866	4.990
0.166	- 0.146	0.477	4.990
0.194	- 0.146	0.188	5.000
0.223	- 0.098	0.059	4.990
0.250	- 0.146	-0.014	4.990
0.278	- 0.146	-0.058	4.990
0.307	- 0.146	-0.058	5.000

4.2.31.1 (Continued)

Yaw 0 to -3 Degree Step Response - Engine Slew Rate: 13.6 deg/sec

Time from Start (seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	0.000	0.000	4.994
0.027	-19.922	-0.462	4.990
0.055	-19.922	-0.794	5.000
0.083	-19.922	-1.169	4.990
0.111	-19.922	-1.573	5.000
0.138	-19.873	-1.978	5.000
0.166	-19.922	-2.353	5.000
0.194	-19.922	-2.655	4.990
0.222	-19.775	-2.828	4.990
0.251	-20.020	-2.930	5.000
0.278	-19.775	-2.958	5.000
0.306	-19.922	-2.987	4.990

Yaw -3 to 0 Degree Step Response - Engine Slew Rate: 15.1 deg/sec

Time from Start (seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	-19.899	-3.074	4.999
0.027	0.000	-2.612	5.000
0.056	0.000	-2.223	5.000
0.083	0.000	-1.818	4.990
0.110	0.000	-1.400	4.990
0.139	0.000	-0.938	5.000
0.166	0.000	-0.563	4.990
0.194	0.049	-0.304	5.005
0.223	0.000	-0.159	5.000
0.250	0.000	-0.102	4.990
0.278	0.000	-0.059	5.000
0.307	0.000	-0.029	5.000

Yaw 0 to +3 Degree Step Response - Engine Slew Rate: 14.9 deg/sec

Time from Start (seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	0.000	0.015	4.999
0.026	19.873	0.418	5.000
0.054	19.873	0.778	4.990
0.082	19.922	1.168	4.990
0.109	19.873	1.615	5.000
0.138	19.824	2.077	5.000
0.166	19.873	2.424	5.000
0.193	19.873	2.669	5.000
0.222	19.873	2.799	4.990
0.250	19.824	2.856	5.000
0.277	19.873	2.886	5.000
0.306	19.873	2.899	4.990

4.2.31.1 (Continued)

Yaw +3 to 0 Degree Step Response - Engine Slew Rate: 14.1 deg/sec

Time from Start (seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	19.899	2.999	5.005
0.026	0.000	2.510	5.000
0.055	0.049	2.135	4.990
0.083	0.049	1.774	4.990
0.111	0.000	1.355	4.990
0.139	0.000	0.952	4.990
0.166	0.000	0.577	5.000
0.194	0.000	0.273	4.990
0.222	0.000	0.086	5.000
0.250	0.000	0.014	5.000
0.279	0.000	0.014	4.990
0.307	0.000	0.014	4.990

Final Hydraulic System and Engine Centering Test
System Pressurized, Locks Off, No Excitation Signal

Function	Measurement	Limits
Hydraulic System Pressure (psia)	3611.19	*
Reservoir Oil Pressure (psia)	173.70	*
Accumulator GN_2 Pressure (psia)	3586.69	*
Accumulator GN_2 Temperature (°F)	77.23	*
Reservoir Oil Level (%)	35.66	*
Pump Inlet Oil Temperature (°F)	124.04	*
Reservoir Oil Temperature (°F)	125.62	*
Aft Bus 2 Current (amps)	42.80	*
T/M Pitch Actuator Position (deg)	- 0.06	*
IU Pitch Actuator Position (deg)	- 0.09	*
T/M Yaw Actuator Position (deg)	- 0.06	*
IU Yaw Actuator Position (deg)	- 0.04	*
IU Substitute 5 volt Power Supply (vdc)	4.99	*
Aft 5 volt Excitation Module (vdc)	5.00	*
Corrected T/M Pitch Actuator Position (deg)	- 0.057	-0.517 to 0.517
Corrected IU Pitch Actuator Position(deg)	- 0.096	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	- 0.068	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	- 0.038	-0.517 to 0.517

* Limits Not Specified

4.2.32 Repressurization System Leak Check (1B59460 NC)

In order to prepare the propellant tanks repressurization system for the propulsion system automatic checkout, this procedure was conducted on 29 and 30 March 1967. The results were accepted by Engineering on 3 April 1967. The purpose of the system is to repressurize the tanks prior to J-2 engine restart.

The test began with the setup of the stage and facility pneumatic sources. After this was accomplished, the check valve reverse seat leakage was measured. The valve, P/N 1B51361-1, S/N 0224, did not allow any reverse leakage.

The integrity pressure test followed. This consisted of pressurizing the ambient helium spheres, P/N 1A49990-505, S/N's 89, 90, 92, 96, 98, 99, 100, 102, 103, and 104, first to 100 psia, and then to 300 psia, and checking for audible air leaks. None were noted. The spheres were then pressurized to 750 psia, and held at this pressure for 3 minutes. They were then vented to 700 psia for the valve and component leak checks.

The valve seat leakage was measured. The LOX and LH_2 repressurization sphere dump valves, P/N 1B43660-507, S/N's 2054 and 2055, had no seat leakage. 25 scim was allowed. The LOX and LH_2 repressurization sphere relief valves, P/N 7851824-503, S/N's 1086 and 1057, also had no seat leakage. The allowance on these was 10 scim.

The component leak check consisted of the following:

a. All fittings from pipe assembly, P/N 1B64148-1 to the LH_2 and LOX repressurization shutoff valves, dump valves, and relief valves.

4.2.32 (Continued)

b. All fittings from the LOX and LH_2 repressurization modules manifolds to the repressurization spheres.

c. Pipe assemblies from transducers D88 and D20 to the LOX and LH_2 sphere manifolds, respectively.

The LOX and LH_2 spheres were next vented to 300 psig, and the leakage downstream of the repressurization control valves to the connection of the repressurization lines, with the tank pressurization lines, was measured.

The system shutdown procedure included venting the spheres to ambient, securing facility sources, and reconnecting all lines which had been removed.

There were no parts shortages affecting this test.

Three leakages were reported on the leak test record sheet. Pipe assembly, P/N 1B66244-1, leaked at the inlet "B" nut. This was corrected by installing a new union, and retorquing the nut. Cap, P/N MC177-C12N, on panel A74, was retorqued. The flare on pipe assembly, P/N 1B66245-1, was scratched, resulting in leakage through the inlet. This condition was recapped to FARR A248639. The flare surface was polished to remove the gouges, and the leakage condition was resolved.

Nine revisions were incorporated, as follows, into the procedure:

a. One revision added the requirement for recording the measured leakages from control valves, P/N 1B43660-507. This requirement had been omitted from the procedure.

b. A revision specified that, during the component leak check, the LOX repress control valves should be opened, and the lines pressurized to hand valve. The valves were then closed, as excessive loss of helium through the pilot bleed saturated the area whenever the valves were held energized during the leak check.

4.2.32 (Continued)

c. Another revision provided for verification that the pneumatic control system was connected to the repressurization system inlets. This was necessary in order to pressurize the system during setup.

d. All steps in the check valve reverse seat leakage test, which had been accomplished during the propulsion system component internal leak check, H&CO 1B59455, were deleted.

e. One revision required verification, during test setup, that the LH_2 tank pressurization system had been connected to pipe assembly, P/N 1B58858-1.

f. A revision specified that, at the end of the integrity pressure test, when the spheres were vented to 700 psia, stage 4 line pressure be set to 700 $\pm$ 50 psia. Also, the repress bottle supply valve was to be left open.

g. Another stated that, during the component leak check, when the LOX spheres were vented to 300 $\pm$ 25 psig, the repress bottle supply valve should be closed.

h. The eighth revision added to the post test instructions requirements for disconnecting the repress lines from the pneumatic control system, and for removing the blanking flange and hand valve from pipe assembly, P/N 1B55285-1. This was necessary for the performance of checkout on the rework of the LOX chilldown pump flange.

i. The final revision pertained to the connection of the above blanking flange and hand valve, to be accomplished during system setup.

4.2.33 All Systems Test (1B66571 A)

After all individual system checkouts were completed, the all systems test demonstrated the combined operation of the stage electrical, hydraulic, propulsion, instrumentation, and telemetry systems under simulated flight conditions. Where practical, the checkout followed the actual flight sequence of prelaunch operations, simulated liftoff, ullage firing, engine start, hydraulic gimballing, engine cutoff, coast period, engine restart and cutoff, attitude control, and stage shutdown. The procedure was conducted twice, once for the umbilicals-in test, and again for the umbilicals-out test. During the umbilicals-in test, the umbilical cables were left connected during the entire procedure, to permit monitoring of the umbilical talkbacks, and to provide complete stage control for trouble shooting and safing operations. During the umbilicals-out test, the umbilical cables were ejected at simulated liftoff, to verify the proper operation of all onboard systems with the umbilicals disconnected. After the completion of the all systems test, the umbilicals were reconnected, and the stage was shut down and completely reset to the proper condition for subsequent shipment to STC.

The all systems test was initiated on 7 April 1967. The umbilicals-in test was completed by the second test run on 8 April 1967, after the correction of GSE and facility electrical power problems. The PCM RF assembly 411A64A200 was rejected for excess noise by FARR A248647, and was replaced prior to the second test run. Other program and procedure problems encoun-

4.2.33 (Continued)

tered during this test run were corrected by revisions to the procedure. The reflected power detector 411MT744, P/N 1A74776-501, failed during the second test run and was rejected and replaced by FARR A248648. The umbilicals-out test was accomplished by the first test run on 8 April 1967. Additional program problems were encountered during this test run, and were corrected by revisions to the procedure. Hardware problems encountered in this test run were covered by FARR's A248649, A248650, A248651 and A248652. All of these problems were resolved, and the procedure was accepted on 28 April 1967. The various function values measured during this procedure are presented in Test Data Table 4.2.33.1. All of these measurements were acceptable and within design requirements, although specific test limits were not defined by the procedure for some of the measurements.

Before the automatic procedure was started for either the umbilicals-in or umbilicals-out test, the stage power setup procedure, H&CO 1B66560, was accomplished, and the GSE electrical systems and the stage propulsion system were manually set up for the test. Initial conditions were then established and the stage power setup test and engine pump purge sequence were conducted. During the power setup test, power was turned on to the propellant utilization inverter and electronics, the EBW pulse sensors, the engine control bus and ignition bus, the APS buses, and aft bus 2; and measurements were made of various currents and voltages, as shown in the Test Data Table. The EBW ullage rocket firing unit disable command, and the propellant dispersion

4.2.33 (Continued).

cutoff command inhibit for both receivers, were also turned on. During the umbilicals-in test only, a switch selector test verified the proper operation of the switch selector. During both tests, the common bulkhead pressure, LH_2 ullage pressure, and LOX ullage pressure were all verified to be greater than 5 psia. For the engine pump purge sequence, pressures were measured for the control helium supply, the LH_2 and LOX repressurization helium spheres, and the ambient helium sphere. The LOX chilldown pump purge and the engine purge were then accomplished, completing this part of the test.

For the next series of prelaunch checks, the auxiliary hydraulic pump coast command was turned on, and the auxiliary pump was verified to be OFF. The LH_2 and LOX chilldown shutoff valves were closed, and the LH_2 and LOX vent valves and fill and drain valves were opened. The proper operation of the LOX and LH_2 point level sensors, fast fill sensors, and overfill sensors was verified by turning on the sensor simulated wet conditions. The simulated wet conditions were left on for all except the overfill sensors, to simulate loaded propellant tanks. The LH_2 and LOX chilldown shutoff valves were opened by a hardwire command and then reclosed by a switch selector command. The LH_2 and LOX prevalves were closed, opened, and reclosed, and the LOX and LH_2 vent valves were closed and reopened, to demonstrate switch selector control of these valves. The LOX tank and LH_2 tank prepressurization sequences were accomplished, with the LH_2 pressuriza-

4.2.33 (Continued)

tion control module hydrogen gas pressure measured during the latter sequence. The LOX and LH_2 fill and drain valves were closed, and the LH_2 directional vent valve was set to the flight position and then back to the ground position. The start tank vent valve was opened, and the start bottle pressure was verified to be less than 40 psia, completing this part of the test.

The EBW and telemetry prelaunch checks were conducted next. A pulse sensor self test verified the operation of the ullage ignition and jettison pulse sensors and the range safety pulse sensors. The PCM RF assembly was turned on, and the current for this unit was measured. A telemetry RF silence check was conducted during the umbilicals-in test only. The telemetry RF silence command was turned on, the change in the forward bus 1 current due to the silence command was measured, and the PCM RF assembly was verified to be OFF. The silence command was turned back off, and the PCM RF assembly was verified to be back ON. The proper operation of the telemetry calibration relay and the RACS was verified next for both tests. The PCM FM transmitter output was measured as the telemetry antenna 1 forward power, the telemetry RF system reflected power was measured, and the telemetry system closed loop VSWR was determined. The static inverter-converter output voltages and operating frequency were then measured. During the umbilicals-in test, the engine cutoff indication and the non-programmed

4.2.33 (Continued)

engine cutoff indication were both verified to be OFF, completing this part of the test. During the umbilicals-out test, the engine cutoff command was turned on, and it was verified that the engine cutoff command indication was ON. The non-programmed engine cutoff indication was then verified to be OFF, completing this part of the test.

The pitch and yaw actuator locks were removed, and the hydraulic system prelaunch checks were conducted. The instrument unit (IU) substitute 5 volt power supply was turned on and the voltage was verified to be 5.0 $\pm$ 0.05 vdc. The hydraulic reservoir gaseous nitrogen mass and corrected oil level were measured. With the hydraulic system unpressurized, the hydraulic system functions were measured as shown in the Test Data Table. The auxiliary hydraulic pump was turned on in the automatic mode to pressurize the hydraulic system, the aft bus 2 current was verified to be 55.0 $\pm$ 20.0 amperes, and the bus voltage was verified to be 56.0 $\pm$ 4.0 vdc. The increase in hydraulic system pressure over a four second period was measured, and the hydraulic system functions were verified to be correct for system operation. With the hydraulic system pressurized, the system functions were remeasured, as shown in the Test Data Table.

The chilldown pump simulator cables were connected to receptacles 404A74A1J3 and 404A74A2J3 on the LOX and LH_2 chilldown inverters. The LOX and LH_2 chilldown pump inverters were turned on and measurements were made of the pump

4.2.33 (Continued)

currents and the inverter operating frequencies and voltages. RF distribution system 2 was turned on and the PCM ground station was set for open loop operation and verified to be in synchronization with the stage PCM output. For a FRATS calibration, a 400 Hz calibration signal was used to measure the reference indication voltages for the LOX and LH_2 circulation pump flow rates, the static inverter-converter operating frequency, and the LH_2 chill-down inverter frequencies; a 100 Hz calibration signal was used to measure the LOX and LH_2 flowmeter reference indication voltages; and a 1500 Hz calibration signal was used to measure the LOX and LH_2 pump speed reference indication voltages. Measurements were then made of the common bulkhead pressure, its 20 and 80 per cent calibration voltages, and, after each calibration, the common bulkhead ambient pressure; the LH_2 ullage pressure, its 20 and 80 per cent calibration voltages, and, after each calibration, the ullage ambient pressure; the LOX ullage pressure; and the LH_2 and LOX emergency detection system pressures.

For the final prelaunch checks, the telemetry antenna 1 forward power and the telemetry system reflected power were measured, and the telemetry system open loop VSWR was determined. The rate gyro was turned on. A RACS test and a telemetry system calibration were then accomplished. For the umbilicals-in test, the battery simulators were turned on, the battery simulator voltages were measured, and the electrical support equipment load bank voltages were measured. For the umbilicals-out test, the checkout batteries were turned on, and the checkout battery voltages were measured. The transducers for the common bulkhead pressure, the LH_2 ullage pressure, and the LOX ullage pressure were all turned off, and the transducer output voltages were measured.

4.2.33 (Continued)

The LH_2 and LOX fast fill sensor wet conditions were turned off. The forward and aft power buses were transferred to internal, and the bus voltages were measured. The range safety receivers were transferred to internal power and verified to be ON, and the low level signal strength indications were measured. The EBW ullage rocket firing unit disable command was turned off, the range safety system safe and arm device was set to the ARM condition, the DDAS antenna input was turned on, and the propellant dispersion cutoff command inhibit was turned off for both range safety receivers. It was verified that the open loop PCM RF signal was being received at the PCM and DDAS ground stations. The cold helium supply shutoff valve was opened. For the umbilicals-out test only, the external power was turned off for the talk-back bus, the forward and aft power buses, and the range safety receivers and EBW firing units; the aft and forward umbilicals were ejected and visually verified to be disconnected, and the local sense indications were verified to be ON. For the umbilicals-in test only, the external powers were all left on, it was verified that the umbilicals remained connected, and the local sense indications were verified to be OFF. The emergency detection system ullage pressures were then measured for both tests. This completed the prelaunch checks with the simulated liftoff.

Following the simulated liftoff, an automatic telemetry system calibration was accomplished, and the pre-separation checks were conducted. The two ullage rocket ignition EBW firing units were charged. The LH_2 and LOX pre-valves were opened and reclosed, and the LH_2 chilldown pump was turned off. The fire ullage ignition command was turned on, and it was verified that the two ullage ignition EBW firing units responded properly and that the ullage

4.2.33 (Continued)

ignition pulse sensors were ON. The aft separate simulation 1 and 2 signals were then turned on to simulate stage separation. During the above part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the ignition EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

APS roll and engine start checks were conducted following the simulated stage separation. The APS firing enable command was turned on, and the instrument unit (IU) substitute -28 volt power was turned on and measured. For the APS roll checks, attitude control nozzles I IV and III II were turned on and off, and attitude control nozzles I II and III IV were turned on and off, while the APS engine 1-1 1-3 and 2-1 2-3 valve open indications were measured for each condition. The LOX chilldown pump was then turned off, the LH_2 and LOX chilldown shutoff valves were opened and reclosed, and the component test power was verified to be 28.0 $\pm$ 2.0 vdc. The engine cutoff command was turned off, and it was verified that the engine cutoff indications were OFF, and the engine ready indication was ON. The engine ready bypass and engine start commands were turned on, the engine start indication was verified to be ON, and the engine start command was turned back off. The LOX flight pressurization system, the LH_2 injector temperature detector bypass, the simulated ignition detected indication, the LH_2 first burn relay, and the simulated mainstage OK indication were all turned on. Verification was made that engine thrust OK indications were OFF, both mainstage OK pressure switch indications were ON, the engine main LOX valve was OPEN, and the gas generator spark system indication was OFF. The LOX pressurization module helium

4.2.33 (Continued)

gas pressure was verified to be greater than 75 psia, the cold helium supply shutoff valve was closed, and the same helium gas pressure was verified to be less than 50 psia. The propellant utilization system activate command was then turned on. The two ullage rocket jettison EBW firing units were charged, the fire ullage jettison command was turned on, and it was verified that both ullage jettison firing units responded properly and that the ullage jettison pulse sensors were ON. During this part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the jettison EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

Following the engine start sequence, the hydraulic gimbal and propellant utilization valve slew checks were conducted, starting with the step response gimbal and LOX valve slew checks. The propellant utilization system ratio valve position indication and the hydraulic system pressure were both measured, and the LOX bridge 1/3 checkout relay was turned on. A series of step response gimbal checks were conducted for 0 to -3 degrees, -3 to 0 degrees, 0 to +3 degrees, and +3 to 0 degrees, in both the pitch and yaw planes. As the results of these checks were compatible with the results of the same checks during the hydraulic system automatic checkout, H&CO 1B66570, (reference paragraph 4.2.31), the measured data is not repeated. Following the gimbal sequence, the propellant utilization system ratio valve position indication was again measured, and the LOX bridge 1/3 checkout relay was turned off. A 0.6 Hz gimbal and LH_2 propellant utilization valve slew check was conducted next. The propellant utilization system ratio valve position

4.2.33 (Continued)

indication and the hydraulic pressure were measured, and the LH_2 bridge 1/3 checkout relay was turned on. A 0.5 degree gimbal signal, at 0.6 Hz, was applied in the pitch and yaw planes. The engine position command currents and resulting instrument unit actuator piston positions were found to be within the required limits throughout the cycling in both planes, for both the umbilicals-in and umbilicals-out tests. The hydraulic actuator piston positions were then measured through both telemetry multiplexers, and the engine pitch and yaw instrument unit position indications were measured. At the completion of the gimbal sequences, the hydraulic system functions were measured with the hydraulic system pressurized, as shown in the Test Data Table. The propellant utilization system ratio valve position indication was measured, the LH_2 bridge 1/3 slew checkout relay was turned off, and the ratio valve position indication was remeasured.

The first burn and coast period sequences were conducted next. The cold helium supply shutoff valve was opened, the LOX pressurization module helium gas pressure was verified to be greater than 75 psia, and the cold helium control valve inlet pressure was measured. The LOX system pressure switch supply was closed, the LOX prepressurization flight switch was verified to be OFF, and the cold helium control valve inlet pressure was again measured. The cold helium supply shutoff valve was closed, the LOX pressurization module helium gas pressure was verified to be less than 50 psia, the LH_2 prepressurization supply was opened, and the LH_2 pressurization module hydrogen gas pressure was measured. The LH_2 system pressure switch supply was closed, the LH_2 flight control switch was verified to be OFF, and the LH_2 pressurization module hydrogen gas pressure was remeasured. The point

4.2.33 (Continued)

level sensor arm command was turned on, and the engine cutoff signal was verified to be OFF. The switch selector engine cutoff was turned on, the engine cutoff indication was verified to be ON, and the engine cutoff was turned off. The LH_2 injector temperature detector bypass was turned off, the auxiliary hydraulic pump coast mode was turned on, and the pump flight mode was turned off. The LH_2 first burn relay was turned off, and the LH_2 pressurization module hydrogen gas pressure was again measured. The LH_2 prepressurization supply was then closed, completing the LH_2 first burn pressurization sequence. The LOX chilldown pump purge was verified to be ON, and the LOX motor control helium pressure was measured. The coast period command was turned on, the LOX flight pressurization system and the propellant utilization system inverter and electronics power were turned off, the engine pump purge control valve enable was turned on, and the engine pump purge regulator pressure was verified to be greater than 50 psia. The simulated ignition detected and the simulated mainstage OK indications were then turned off.

The engine restart preparation sequence was started next. The 70 pound ullage engine command number 1 was turned on, the LH_2 continuous vent valves were opened, and the ullage engine command was turned back off. The engine pump purge control valve enable was turned off, and the engine pump purge regulator pressure was verified to be less than 30 psia. The propellant utilization system inverter and electronics power was turned on, and the LH_2 boiloff bias signal voltage was measured. The propellant utilization system bias cutoff was turned on, and the boiloff bias signal voltage was verified to be greater than 5.0 vdc. The 70 pound ullage engine command

4.2.33 (Continued)

number 1 was turned back on, and the LH_2 continuous vent valves were closed. The LOX tank repressurization sequence was then started. The LOX system pressure switch supply was opened, and the supply pressure was verified to be greater than 35 psia. The LOX repressurization control valve was opened, the LOX repressurization sphere pressure was verified to drop at least 50 psia, and the LOX repressurization flight switch was verified to be ON. The LOX repressurization sphere helium pressure was then measured, and the LOX repressurization control valve was closed, completing the LOX tank repressurization sequence. The LOX and LH_2 chilldown pumps were turned on, and the chilldown inverter operating frequencies and output voltages were measured. The LH_2 tank repressurization sequence was then started. The LH_2 system pressure switch supply was opened, and the supply pressure was verified to be greater than 25 psia. The LH_2 repressurization control valve was opened, the LH_2 tank helium sphere repressurization pressure was verified to drop at least 50 psia, and was measured. The LH_2 repressurization control valve was then closed, completing the LH_2 tank repressurization sequence. The LH_2 and LOX chilldown pumps were turned off, and the inverter operating frequencies and output voltages were measured. The cold helium supply shutoff valve was then opened, completing the engine restart preparations.

The engine restart sequence was conducted next. The engine ready bypass command and the engine start command were turned on. The coast period command was turned off, and the LH_2 injector temperature detector bypass was turned on. The simulated ignition detected indication and the LOX flight pressurization system were turned on, and the engine start command

4.2.33 (Continued)

and the 70 pound ullage engine command number 1 were turned off. The LH_2 second burn command and the simulated mainstage OK indication were turned on. Verification was made that the engine thrust OK indications were OFF, the engine main LOX valve was OPEN, and the gas generator spark system indicator was OFF. The LOX pressurization module helium gas pressure was verified to be greater than 50 psia, the cold helium supply shutoff valve was closed, and the same pressure was verified to be less than 50 psia. This completed the engine restart sequence, and an LH_2 second burn repressurization sequence was conducted. The LH_2 prepressurization supply was opened, and the LH_2 pressurization module hydrogen gas pressure was measured. The LH_2 system pressure switch supply was closed, the LH_2 tank control valve enabled indication was verified to be OFF, and the LH_2 pressurization module hydrogen gas pressure was remeasured. The LH_2 prepressurization supply was then closed, completing the LH_2 second burn pressurization sequence.

The engine cutoff sequence was then conducted. The engine cutoff command was turned on and verified. The simulated ignition detected signal, the LH_2 second burn command, and the LOX flight pressurization system were all turned off; the coast period command was turned on; and the LOX chilldown pump purge control valve was turned off. The engine cutoff command was then turned off, the LH_2 injector temperature detector bypass was turned off, and the engine ready bypass was turned on.

A series of checks, conducted on the LOX and LH_2 point level sensors, verified that a dry condition of any one LOX or LH_2 sensor would not cause engine cutoff, but that a dry condition of any two LOX sensors or any two

4.2.33 (Continued)

LH_2 sensors would cause engine cutoff. The sensors were checked by turning off the simulated wet conditions for the combinations of LOX sensors 1 and 2, 1 and 3, and 2 and 3, and LH_2 sensors 1 and 2, 1 and 3, and 2 and 3. During the umbilicals-in test only, the operating time of the LOX depletion engine cutoff timer was measured at 0.554 seconds for each combination of LOX sensors, within the 0.560 $\pm$ 0.025 seconds limits.

The emergency detection system and range safety system tests were conducted next. The emergency detection system 1 and 2 engine cutoff commands were individually turned on, and it was verified that each command properly caused engine cutoff. A series of checks then verified that the range safety EBW firing unit arm and engine cutoff command properly charged the range safety firing units and caused engine cutoff, and that the range safety propellant dispersion command properly fired the range safety EBW firing units to cause propellant dispersion. During the umbilicals-in test only, additional checks verified that the range safety 1 and 2 receiver propellant dispersion cutoff command inhibits properly prevented engine cutoff and EBW firing unit operation. Following the propellant dispersion checks, the point level sensor arm command, the coast period command, the propellant utilization system activate command, and the propellant utilization inverter and electronics power, were all turned off. The range safety system off command was turned on, both range safety receiver low level signal strength indications were verified to be 0.0 $\pm$ 0.3 vdc, and the command was turned off, completing the range safety system tests.

A series of APS yaw and pitch attitude control checks were conducted next. The APS attitude control nozzles I IV and III IV were turned on and off

4.2.33 (Continued)

while the APS engine 1-1 and 2-3 valve open indications were measured for each condition. Attitude control nozzles I II and III II were turned on and off while the engine 1-3 and 2-1 valve open indications were measured, and attitude control nozzles I P and III P were individually turned on and off while the engine 1-2 and 2-2 valve open indications were individually measured. A final automatic telemetry system calibration was then accomplished to complete the all systems test.

Engineering comments noted several parts shortages during the procedure:

a. Seven interim use actuation control modules, P/N 1B65292-501, were installed per SEO's 1B52500-005 and 1B58003-009 in place of actuation control modules 403A75A1, 404A9, 404A43, 404A44, 411A2, 411A3, and 411A30, P/N 1B66692-1.

b. An interim use LOX vent and relief valve, P/N 1A49590-513-018, was installed per SEO 1A49590-018 in place of LOX vent and relief valve 424A1, P/N 1A49590-515.

c. An interim use continuous vent valve, P/N 1B51753-501-007, was installed per SEO 1B67193-004 in place of continuous vent valve 411A32, P/N 1B67193-501-002.

d. Interim use pipe assemblies, P/N's 1B64602-1, 1B64603-1, and 1B64618-1, and restrictor, P/N 1B40622-509, were installed at location 411A32 per SEO 1B52500-007 in place of pipe assemblies, P/N's 1B64609-1, 1B64608-1, 1B64607-1, and 1B64606-1; expander, P/N MC239C4-2; tee, MC162C4; and restrictor, P/N 1B40622-505.

e. Three non-flight Rocketdyne transducers, P/N NA5-27323T3, were installed on the J-2 engine. These were for measurement C1, the LH_2 turbine inlet temperature; measurement C2, the LOX turbine inlet temperature; and measurement C215, the LOX turbine outlet temperature.

As noted, the following failure and rejection reports were written during this procedure:

a. FARR A248647 noted excess noise spikes on the output signal of PCM RF assembly 411A64A200, P/N 1B52721-509, S/N 33. The noise exceeded 20 per cent of the pulse amplitude, and should not have exceeded 5 per cent. The unit was returned to the vendor, and PCM RF assembly, P/N 1B52721-509, S/N 34, was installed.

4.2.33 (Continued)

b. FARR A248648 noted that reflected power detector 411MT744, P/N 1A74776-501, S/N 2-0136, had a reading of 13.2 millivolts, below the 13.4 millivolt minimum. The power detector was removed and detector, S/N 2-0178, was installed.

c. FARR A248649 was written for rapid cycling of the shutoff valve on engine pump purge module, P/N 1A58347-505, S/N 63. The inlet orifice diameter was 0.024 inch, rather than the required 0.018 inch. The module was removed, and a new module, S/N 71, was installed.

d. FARR A248650 noted that pressure switch 403S2, P/N 1B52623-515, S/N 14, cycled twice per second for 10 minutes, but should have cycled only once per second. The switch was removed and a new switch, S/N 15, was installed.

e. FARR A248651 was written because the grommet in plug 403W8P32 of wire harness, P/N 1B63296-1, was damaged at pin D. The plug mated to pressure switch 403S2 on the thrust structure. Plug 403W8P32 was removed and replaced.

f. FARR A248652 was written for excessive noise levels of 2.5 per cent over 1 second for measurement D182, transducer 409MT649, P/N 1B40242-569, S/N 569-2, and measurement D218, transducer 403MT750, P/N 1B53574-501, S/N 501-19; and an excessive noise level of 71 per cent over 1 second for measurement D576, transducer 410MT601, P/N 1B40242-509, S/N 509-16. The peak-to-peak noise level should not have exceeded 2 to 5 per cent for 1 second durations, per report SM 46847 used for evaluating open loop telemetry test data. The discrepancies were acceptable to Engineering.

A total of fifty-seven revisions were made to the procedure, with one of these later deleted. The remaining fifty-six covered:

a. Thirty-two revisions corrected procedure and program errors to permit proper accomplishment of the test.

b. One revision changed the expected calibration voltages for the 400 Hz functions, as the DSV-4B-296 telemetry signal distribution unit, P/N 1B41812-1, could not be adjusted for a 400 Hz calibration signal.

c. Two revisions changed LH_2 and LOX chilldown shutoff valve open and close commands from switch selector control to hardwire control at two points in the program, as hardwire functions were required at those points.

4.2.33 (Continued)

d. Two revisions changed the program to look for telemetry measurements rather than hardwire measurements at four places, as the umbilicals would be disconnected at these points in the umbilicals-out test.

e. One revision changed the expected chilldown inverter voltages at four steps in the program to be 0.0 ± 1.5 vac rather than VOLT1 ± 1.5 vac. VOLT1 was the aft bus 2 voltage of 56 vdc, while the inverter output voltages should be 0.0 volts, as the chilldown pumps were turned off at this point.

f. One revision deleted three steps from the initial conditions scan setup, as they were not required for operational stages.

g. One revision deleted two steps from a backup routine to prevent turning on the range safety receiver 1 external power, as the external power was not on in the program main flow at that point.

h. One revision added steps to a backup routine to return the PCM ground station to closed loop operation, to provide the correct conditions for re-entering the program main flow.

i. One revision changed the GSE setup of the Model DSV-4B-136 destruct system test set, P/N 1A59952-1, to provide and measure a 400.0 ± 8.0 Hz calibration signal.

j. One revision added the Model DSV-4B-192 command destruct receiver open loop antenna, P/N 1B53355-1, and the Model DSV-4B-268 aft interface unit, P/N 1A89815-1, to the Mandatory End Item list, as their use was required for the test.

k. One revision added a telemetry receiving antenna, quantity one, to the Non-End Item Requirements list for use during the test.

l. Two revisions checked the replacement PCM RF assembly, P/N 1B52721-509, S/N 34, (reference FARR A248647), per the antenna checkout procedure, H&CO 1B64679, except using a Bird Electronics Model 611 wattmeter. The PCM transmitter was found to have a center frequency of 258.509 MHz, within the 258.500 ± 0.26 MHz limits, and a deviation of 36.0 kHz, within the 36.0 ± 3.0 kHz limits. Power checks showed a forward power of 21.8 watts, a forward power detector output of 108 mvdc, a reflected power of 2.4 watts, and a reflected power detector output of 12 mvdc. All of these acceptable.

m. One revision made additional checks of the replacement reflected power detector, P/N 1A74776-501, S/N 2-0178, (reference FARR A248648), and the PCM RF assembly. Open loop measurements showed a forward power of 25.25 watts, a reflected power of 0.75 watts, and a VSWR of 1.416, while closed loop measurements showed a forward power of 25.55 watts, a reflected power of 0.37 watts, and a VSWR of 1.274. All of these measurements were acceptable.

4.2.33 (Continued)

n. One revision provided and documented testing of the replacement engine pump purge module, P/N 1A58347-505, S/N 71, and pressure switch, P/N 1B52623-515, S/N 15, (reference FARR's A248649 and A248650). Leak checks, pressure switch pickup and dropout checks, and interlock function checks were all satisfactory.

o. One revision changed the GSE setup procedure involving the flex hose normally connecting the LH_2 and LOX prevalve actuation control module vent port to the GSE prevalve ground supply port. To prevent slowing down the prevalve and chilldown valve movements during timed cycles, this flex hose was left disconnected until its use was required later in the program.

p. One revision deleted the normal shutdown sequence during the umbilicals-in test. A SIM interrupt plus a program error caused a computer malfunction. The computer was manually shut off, and the stage was shut down manually. The program error was corrected prior to the umbilicals-out test run.

q. Two revisions changed the tolerances on the chilldown inverter output voltages from $\pm$ 3.0 vac to -4.5, +2.0 vac, to allow for a 2.5 vac drop across the inverter. One other revision changed the expected inverter output voltages during the umbilicals-out test, from VOLT1, the aft bus 2 voltage, to 55 and 54 vac, as the aft bus 2 voltage was not measured after the umbilicals were ejected.

r. One revision deleted a previous revision that was written in error.

s. One revision changed the acceptable LH_2 ullage pressure measurements because RFI caused high readings, (reference FARR A248652). The measured values were changed from 14.7 $\pm$ 1.0 psia to 23.0 $\pm$ 3.0 psia at one place; from 1.0 $\pm$ 0.1 vdc to 2.0 $\pm$ 0.5 vdc at one place; from ambient $\pm$ 1.0 psia to ambient $\pm$ 11.0 psia at two places; and from 4.0 $\pm$ 1.0 vdc to 4.8 $\pm$ 3.0 vdc at one place.

t. One revision corrected the RACS coding for function 2106 on the digital data tape, to correct a DDT error.

4.2.33.1 Test Data Table, All Systems Test

Function	Umbil.-In	Umbil.-Out	Limits
Power Setup			
PU Inv. and Elect. Current (amps)	3.3	3.8	5.0 max.
Aft Bus 1 Current (Eng. Cont. Bus On) (amps)	1.50	1.20	3.0 ± 3.0
Aft Bus 1 Voltage (vdc)	28.08	28.04	28.0 ± 2.0
Engine Control Bus Voltage (vdc)	27.78	27.78	Bus 1 ± 1.0
Aft Bus 1 Current (Eng. Ign. Bus On) (amps)	1.60	1.50	3.0 ± 3.0
Aft Bus 1 Voltage (vdc)	28.08	28.12	28.0 ± 2.0
Engine Ignition Bus Voltage (vdc)	27.84	27.84	Bus 1 ± 1.0
Aft Bus 1 Current (APS Bus On) (amps)	2.30	3.40	3.0 ± 3.0
Aft Bus 2 Current (amps)	0.20	0.00	5.0 max.
Aft Bus 2 Voltage (vdc)	56.32	56.24	56.0 ± 4.0
Engine Pump Purge			
Cont. He. Reg. Discharge Press. D014 (psia)	543.2	543.2	*
Cold Helium Sphere Pressure D016 (psia)	697.9	694.0	*
Eng. Cont. He. Supply Press. D019 (psia)	1059.9	1045.6	*
LH_2 Repress. He. Sphere Press. D020 (psia)	712.3	701.1	*
LOX Repress. He. Sphere Press. D088 (psia)	727.3	712.3	*
Amb. He. Pneu. Sphere Press. D236 (psia)	697.4	682.4	*
LH_2 Prepressurization Sequence			
LH_2 Press. Control Module GH_2 Press. D104 (psia)	58.64	60.83	50.0 min.
EBW and Telemetry Checks			
PCM RF Assembly Current (amps)	4.500	5.101	4.5 ± 3.0
Forward Bus 1 Current Change (T/M RF Silence On) (amps)	4.700	**	3.0 min.
T/M Antenna 1 Forward Power (watts)	29.713	29.173	15.0 min.
T/M RF System Reflected Power (watts)	0.422	0.422	2.0 max.

* Limits Not Specified
** Measurement Not Applicable

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Telemetry System Closed Loop VSWR	1.271	1.271	2.0 max.
Inv.-Conv. 115 vac Output (vac)	114.23	114.28	115.0 ± 3.45
Inv.-Conv. 5 vdc Output (vdc)	5.01	4.98	4.8 ± 0.3
Inv.-Conv. 21 vdc Output (vdc)	21.71	21.60	21.25 ± 1.25
Inv.-Conv. Operating Frequency (Hz)	400.02	399.25	400.0 ± 6.0
Hydraulic System Checks			
Reservoir GN_2 Mass (lbs)	1.935	1.898	1.925 ± 0.2
Corrected Reservoir Oil Level (%)	100.5	97.7	95.0 min.
Hydraulic System Unpressurized			
Hydraulic System Pressure (psia)	1372.31	3604.63	*
Accumulator GN_2 Pressure (psia)	2345.50	3578.44	*
Accumulator GN_2 Temperature (°F)	63.53	92.53	*
Reservoir Oil Temperature (°F)	63.53	75.27	*
Reservoir Oil Level (%)	91.45	40.52	*
Reservoir Oil Pressure (psia)	76.81	167.15	*
Pump Inlet Oil Temperature (°F)	70.19	78.41	*
T/M Yaw Actuator Position (deg)	1.04	1.18	*
Corrected T/M Yaw Act. Pos. (deg)	1.037	1.169	*
IU Yaw Actuator Position (deg)	0.85	1.05	*
Corrected IU Yaw Act. Pos. (deg)	0.862	1.050	*
T/M Pitch Actuator Position (deg)	0.12	0.06	*
Corrected T/M Pitch Act. Pos. (deg)	0.123	0.068	*
IU Pitch Actuator Position (deg)	0.27	0.19	*
Corrected IU Pitch Act. Pos. (deg)	0.263	0.194	*
IU Substitute 5v Power Supply (vdc)	4.99	5.00	*
Aft 5v Excitation Module (vdc)	5.00	5.00	*
Aft Bus 2 Current (amps)	0.00	**	*
Aft Checkout Battery 2 Current (amps)	**	0.80	*
Hydraulic System Pressurized			
Hyd. System 4 Second Press. Change (psia)	291.3	284.8	200.0 min.
Hydraulic System Pressure (psia)	3604.63	3604.63	*
Accumulator GN_2 Pressure (psia)	3578.44	3578.44	*
Accumulator GN_2 Temperature (°F)	84.68	92.53	*
Reservoir Oil Temperature (°F)	66.66	75.27	*
Reservoir Oil Level (%)	42.51	40.52	*
Reservoir Oil Pressure (psia)	165.84	167.15	*
Pump Inlet Oil Temperature (°F)	63.93	72.14	*
T/M Yaw Actuator Position (deg)	-0.03	-0.06	*
Corrected T/M Yaw Act. Pos. (deg)	-0.036	-0.061	*
IU Yaw Actuator Position (deg)	-0.18	-0.19	*
Corrected IU Yaw Act. Pos. (deg)	-0.180	-0.188	*

* Limits Not Specified
** Measurement Not Applicable

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
T/M Pitch Actuator Position (deg)	-0.10	-0.08	*
Corrected T/M Pitch Act. Pos. (deg)	-0.088	-0.080	*
IU Pitch Actuator Position (deg)	0.06	0.06	*
Corrected IU Pitch Act. Pos. (deg)	0.060	0.053	*
IU Substitute 5v Power Supply (vdc)	5.00	4.99	*
Aft 5v Excitation Module (vdc)	5.00	5.00	*
Aft Bus 2 Current (amps)	41.80	**	*
Aft Checkout Battery 2 Current (amps)	**	0.80	*
Chilldown Inverter Checks			
LOX C/D Pump Current (amps)	18.80	21.00	20.0 ± 5.0
LOX C/D Inv. Frequency (Hz)	400.2	400.2	400.0 ± 4.0
LOX C/D Inv. Phase AB Volt. (vac)	51.5	51.5	*
LOX C/D Inv. Phase AC Volt. (vac)	51.6	51.4	*
LH_2 C/D Pump Current (amps)	18.20	21.80	20.0 ± 5.0
LH_2 C/D Inv. Frequency (Hz)	399.9	399.9	400.0 ± 4.0
LH_2 C/D Inv. Phase AB Volt. (vac)	51.7	51.7	*
LH_2 C/D Inv. Phase AC Volt. (vac)	51.9	51.8	*
FRATS Calibration			
LOX Circ. Pump Flowrate Ind. (vdc)	3.882	3.882	3.836 ± 0.100
LH_2 Circ. Pump Flowrate Ind. (vdc)	3.887	3.896	3.836 ± 0.100
Static Inv.-Conv. Frequency Ind. (vdc)	3.189	3.158	*
LH_2 Chilldown Inv. Freq. Ind. (vdc)	3.185	3.158	*
LOX Chilldown Inv. Freq. Ind. (vdc)	3.199	3.169	*
LOX Flowmeter Indication (vdc)	1.671	1.677	1.667 ± 0.100
LH_2 Flowmeter Indication (vdc)	1.677	1.677	1.667 ± 0.100
LOX Pump Speed Indication (vdc)	3.179	3.153	3.125 ± 0.100
LH_2 Pump Speed Indication (vdc)	1.267	1.267	1.250 ± 0.100
Pressure Measurements			
Common Bulkhead Pressure (psia)	14.376	14.587	14.7 ± 0.5
Common Bulkhead 20% Calib. (vdc)	0.994	0.994	1.0 ± 0.1
Common Bulkhead Amb. Press. (psia)	14.376	14.587	14.7 ± 0.5
Common Bulkhead 80% Calib. (vdc)	3.970	3.970	4.0 ± 0.1
Common Bulkhead Amb. Press. (psia)	14.402	14.587	14.7 ± 0.5
LH_2 Ullage Pressure (psia)	20.288	24.988	23.0 ± 3.0
LH2 Ullage 20% Calib. (vdc)	1.585	2.124	2.0 ± 0.5
LH_2 Ullage Amb. Press. (psia)	20.236	25.094	14.7 ± 11.0

* Limits Not Specified
** Measurement Not Applicable

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
LH_2 Ullage 80% Calib. (vdc)	4.574	5.090	4.8 ± 0.3
LH_2 Ullage Amb. Press. (psia)	20.288	25.199	14.7 ± 11.0
LOX Ullage Pressure (psia)	15.120	15.173	14.7 ± 1.0
LH_2 EDS Transducer 1 Press. (psia)	15.4	15.2	14.7 ± 1.0
LH_2 EDS Transducer 2 Press. (psia)	15.2	15.1	14.7 ± 1.0
LOX EDS Transducer 1 Press. (psia)	15.1	15.1	14.7 ± 1.0
LOX EDS Transducer 2 Press. (psia)	15.1	15.2	14.7 ± 1.0
Final Prelaunch Checks			
T/M Antenna 1 Forward Power (watts)	29.713	29.713	15.0 min.
T/M RF System Reflected Power (watts)	0.660	1.032	2.0 max.
Telemetry System Open Loop VSWR	1.350	1.458	3.0 max.
Fwd. Bus 1 Batt. Sim. (Bus 4D30) (vdc)	28.20	**	28.0 ± 2.0
Fwd. Bus 2 Batt. Sim. (Bus 4D20) (vdc)	28.20	**	28.0 ± 2.0
Aft Bus 1 Batt. Sim. (Bus 4D10) (vdc)	28.08	**	28.0 ± 2.0
Aft Bus 2 Batt. Sim. (Bus 4D40) (vdc)	55.36	**	56.0 ± 4.0
Bus 4D20 ESE Load Bank (vdc)	0.00	**	0.0 ± 1.0
Bus 4D40 ESE Load Bank (vdc)	0.24	**	0.0 ± 1.0
Bus 4D30 ESE Load Bank (vdc)	0.00	**	0.0 ± 1.0
Bus 4D10 ESE Load Bank (vdc)	0.16	**	0.0 ± 1.0
Fwd. Bus 1 C/O Batt. (Bus 4D30) (vdc)	**	29.96	30.0 ± 2.0
Fwd. Bus 2 C/O Batt. (Bus 4D20) (vdc)	**	29.76	30.0 ± 2.0
Aft Bus 1 C/O Batt. (Bus 4D10) (vdc)	**	29.84	30.0 ± 2.0
Aft Bus 2 C/O Batt. (Bus 4D40) (vdc)	**	60.48	60.0 ± 4.0
Common Bulkhead Press. Transducer (vdc)	0.000	0.010	0.0 ± 0.35
LH_2 Ullage Pressure Transducer (vdc)	0.000	0.005	0.0 ± 0.35
LOX Ullage Pressure Transducer (vdc)	0.114	0.140	0.0 ± 0.35
Fwd. Bus 1 Internal (Bus 4D31) (vdc)	28.08	29.64	28.0 ± 2.0
Fwd. Bus 2 Internal (Bus 4D21) (vdc)	27.72	28.48	28.0 ± 2.0
Aft Bus 1 Internal (Bus 4D11) (vdc)	28.16	29.60	28.0 ± 2.0
Aft Bus 2 Internal (Bus 4D41) (vdc)	54.48	55.44	56.0 ± 4.0
Receiver 1 Low Level Signal (vdc)	3.64	3.58	2.5 min.
Receiver 2 Low Level Signal (vdc)	3.67	3.63	2.5 min.
LH_2 EDS 1 Ullage Pressure (psia)	15.06	14.94	14.7 ± 1.0
LH_2 EDS 2 Ullage Pressure (psia)	15.08	15.21	14.7 ± 1.0
LOX EDS 1 Ullage Pressure (psia)	15.15	15.09	14.7 ± 1.0
LOX EDS 2 Ullage Pressure (psia)	15.08	15.14	14.7 ± 1.0

** Measurement Not Applicable

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
APS Roll Checks			
IU Substitute -28 volt Power (vdc)	-28.719	-28.958	-28.0 ± 2.0
Attitude Control Nozzles I IV and III II On			
Engine 1-1 1-3 Valve Open Indic. (vdc)	4.333	4.343	4.3 ± 0.250
Engine 2-1 2-3 Valve Open Indic. (vdc)	4.204	4.261	4.1 ± 0.250
Attitude Control Nozzles I IV and III II Off			
Engine 1-1 1-3 Valve Open Indic. (vdc)	0.000	0.000	0.0 ± 0.250
Engine 2-1 2-3 Valve Open Indic. (vdc)	0.005	0.000	0.0 ± 0.250
Attitude Control Nozzles I II and III IV On			
Engine 1-1 1-3 Valve Open Indic. (vdc)	4.225	4.286	4.3 ± 0.250
Engine 2-1 2-3 Valve Open Indic. (vdc)	4.179	4.251	4.1 ± 0.250
Attitude Control Nozzles I II and III IV Off			
Engine 1-1 1-3 Valve Open Indic. (vdc)	-0.005	0.000	0.0 ± 0.250
Engine 2-1 2-3 Valve Open Indic. (vdc)	0.000	0.000	0.0 ± 0.250
Hydrualic Gimbal Step Response Check			
Ratio Valve Pos. Indic., (Relay Off) (vdc)	2.64	2.64	2.65 ± 0.12
Hydraulic System Pressure (psia)	3605.0	3614.0	3500.0 min.
Ratio Valve Pos. Indic., (Relay On) (vdc)	0.12	0.12	1.0 max.
Hydraulic Gimbal 0.6 Hz Check			
Ratio Valve Pos. Indic., (Relay Off) (vdc)	2.52	2.53	2.65 ± 0.14
Hydraulic System Pressure (psia)	3601.0	3601.0	3500.0 min.
Pitch Act. Piston Position, AO (deg)	-0.064	-0.064	0.0 ± 0.517
Pitch Act. Piston Position, BO (deg)	-0.049	-0.064	0.0 ± 0.517
Yaw Act. Piston Position, AO (deg)	-0.045	-0.045	0.0 ± 0.517
Yaw Act. Piston Position, BO (deg)	-0.045	-0.045	0.0 ± 0.517
Engine Pitch Position, IU (deg)	0.104	0.090	0.0 ± 0.517
Engine Yaw Position, IU (deg)	-0.180	-0.149	0.0 ± 0.517

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Hydrualic System Pressurized			
Hydraulic System Pressure (psia)	3591.50	3601.38	*
Accumulator GN_2 Pressure (psia)	3578.44	3578.44	*
Accumulator GN_2 Temperature (°F)	69.79	74.88	*
Reservoir Oil Temperature (°F)	138.27	120.88	*
Reservoir Oil Level (%)	49.73	42.14	*
Reservoir Oil Pressure (psia)	169.77	169.77	*
Pump Inlet Oil Temperature (°F)	148.17	132.34	*
T/M Yaw Actuator Position (deg)	-0.06	-0.03	*
Corrected T/M Yaw Act. Pos. (deg)	-0.068	-0.036	*
IU Yaw Actuator Position (deg)	-0.17	-0.17	*
Corrected IU Yaw Act. Pos. (deg)	-0.158	-0.165	*
T/M Pitch Actuator Position (deg)	-0.06	-0.06	*
Corrected T/M Pitch Act. Pos. (deg)	-0.057	-0.057	*
IU Pitch Actuator Position (deg)	0.10	0.07	*
Corrected IU Pitch Act. Pos. (deg)	0.098	0.074	*
IU Substitute 5v Power Supply (vdc)	4.99	5.00	*
Aft 5v Excitation Module (vdc)	5.00	5.00	*
Aft Bus 2 Current (amps)	44.40	**	*
Aft Checkout BAttery 2 Current (amps)	**	46.00	*
Ratio Valve Pos. Indic. (Relay On) (vdc)	4.682	4.682	3.5 min.
Ratio Valve Pos. Indic. (Relay Off) (vdc)	2.671	2.682	2.65 ± 0.12
First Burn and Coast Period			
Cold Helium Control Valve Inlet Pressure D225:			
Cold Helium Supply Open (psia)	198.44	196.80	*
LOX Press. Sw. Supply Closed (psia)	78.96	80.06	*
LH_2 Press. Module GH_2 Pressure D104:			
LH_2 Prepress. Supply Open (psia)	100.11	101.20	*
LH_2 Press. Sw. Supply Closed (psia)	70.65	76.10	*
LH_2 First Burn Relay Off (psia)	54.28	60.83	*
LOX Mot. Control He. Press. D103 (psia)	39.44	39.28	*
Engine Restart Preparations			
LH_2 Boiloff Bias Signal M010 (vdc)	0.48	0.51	0.0 ± 3.0
LOX Repress. Sphere GHe Press. D088 (psia)	99.09	43.00	*

* Limits Not Specified
** Measurement Not Applicable

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Chilldown Pumps On			
LOX C/D Inv. Frequency (Hz)	400.11	399.97	400.0 ± 4.0
LOX C/D Inv. Phase AB Volt. (vac)	53.0	51.9	55.0, -4.5, +2.0
LOX C/D Inv. Phase AC Volt. (vac)	53.0	51.9	55.0, -4.5, +2.0
LH_2 C/D Inv. Frequency (Hz)	399.95	399.84	400.0 ± 4.0
LH_2 C/D Inv. Phase AB Volt. (vac)	52.8	50.3	54.0, -4.5, +2.0
LH_2 C/D Inv. Phase AC Volt. (vac)	52.8	50.3	54.0, -4.5, +2.0
LH_2 Tank He. Sph. Repress. D020 (psia)	476.8	431.9	*
Chilldown Pumps Off			
LOX C/D Inv. Frequency (Hz)	389.5	389.5	390.0 ± 1.0
LOX C/D Inv. Phase AB Volt. (vac)	0.00	0.00	0.0 ± 1.5
LOX C/D Inv. Phase AC Volt. (vac)	0.00	0.00	0.0 ± 1.5
LH_2 C/D Inv. Frequency (Hz)	389.5	389.5	390.0 ± 1.0
LH_2 C/D Inv. Phase AB Volt. (vac)	-0.07	0.00	0.0 ± 1.5
LH_2 C/D Inv. Phase AC Volt. (vac)	0.00	0.00	0.0 ± 1.5
LH_2 Second Burn Repressurization			
LH_2 Press. Module GH_2 Pressure D104:			
LH_2 Prepress. Supply Open (psia)	113.199	106.654	*
LH_2 Press. Sw. Supply Closed (psia)	80.467	72.828	*
APS Yaw and Pitch Checks			
Attitude Control Nozzles I IV and III IV On			
Engine 1-1 Valve Open Indic. (vdc)	4.23	4.28	4.3 ± 0.25
Engine 2-3 Valve Open Indic. (vdc)	4.21	4.18	4.1 ± 0.25
Attitude Control Nozzles I IV and III IV Off			
Engine 1-1 Valve Open Indic. (vdc)	0.00	-0.00	0.0 ± 0.25
Engine 2-3 Valve Open Indic. (vdc)	0.00	-0.00	0.0 ± 0.25
Attitude Control Nozzles I II and III II On			
Engine 1-3 Valve Open Indic. (vdc)	4.24	4.21	4.3 ± 0.25
Engine 2-1 Valve Open Indic. (vdc)	4.21	4.17	4.1 ± 0.25
Attitude Control Nozzles I II and III II Off			
Engine 1-3 Valve Open Indic. (vdc)	0.00	0.00	0.0 ± 0.25
Engine 2-1 Valve Open Indic. (vdc)	0.00	0.00	0.0 ± 0.25

* Limits Not Specified

4.2.33.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Attitude Control Nozzle I P On Engine 1-2 Valve Open Indic. (vdc)	4.36	4.34	4.3 ± 0.25
Attitude Control Nozzle I P Off Engine 1-2 Valve Open Indic. (vdc)	-0.00	0.00	0.0 ± 0.25
Attitude Control Nozzle III P On Engine 2-2 Valve Open Indic. (vdc)	4.25	4.26	4.1 ± 0.25
Attitude Control Nozzle III P Off Engine 2-2 Valve Open Indic. (vdc)	0.00	-0.00	0.0 ± 0.25

4.2.34 Forward Skirt Thermo-Conditioning System Securing (1B62965 A)

Setup and checkout procedures for the forward skirt thermo-conditioning system included a system cleanliness check, a drain and dry procedure, a system leak check, and preparation of the thermo-conditioning system for stage shipment to STC.

The system cleanliness check ensured that the water/methanol solution was free of contaminants after VCL checkout. The leak check ensured that leakages did not exceed a leakage factor of 64 ounces per year, and individual leaks did not exceed 5 ounces per year. Preparation for stage shipment ensured that moisture content did not exceed a dewpoint of 25°F.

All these activities were accomplished on 12 April 1967, and Engineering review and acceptance was made on 14 April 1967.

The system setup for post checkout testing consisted of first verifying ground cable connections and hose assembly connections, P/N's 1B37640-1 and -501. The servicer water/methanol reservoir liquid level was then verified to be less than 2 inches above the ADD mark, and the system visually inspected for leakage. Reservoir vent line connections and hose assembly connections, P/N's 1B37461-1 and -501, were verified.

Following an inspection of the cold plates for open equipment mounting bolt holes and improperly torqued bolts, the remote switch was set to ON LOCAL, and the start time, 1600 hours, recorded. A 1000 millilitre coolant sample was drawn from both the fluid sample pressure valve and the fluid sample return valve, after one pint of fluid had been drawn from each valve to purge the valves of possible impurities. The samples were found to be acceptable per 1P00093. The remote switch was turned to OFF, and the stop

4.2.34 (Continued)

time recorded at 1745 hours. The running time of 1 hour, 45 minutes was also recorded.

The drain and dry procedure consisted of flowing GN_2 through the system under 10 ± 1 psig pressure for 5 minutes, and then under 32 ± 1 psig for 2 hours. The system was then drained and checked for a moisture content of less than 4430 ppm of water/methanol vapor at a 25°F dewpoint, and was found to be satisfactory.

A gaseous leak detector, P/N 1B37134-1, was then connected to the system, and valves and freon pressures adjusted to 20 +10 -0 psig. The cycle was repeated twice, followed by a purge cycle under 32 ± 1 psig. With the supply pressure gage reading 32 ± 1 psig, and the leak detector sensitivity switch set at one on the R12 ounce/year scale, all system B-nuts and fittings, manifold weld areas, inlet and outlet bosses (welds), and manifold flexible bellows were leak checked. The test was then repeated with the leak detector sensitivity switch set at two, and a leakage factor computed that was less than the yearly limit. No detectable leaks were found when the switch was set at five, thus satisfying the requirements.

The drain and dry procedure was repeated and the dewpoint was found to be acceptable. The thermo-conditioning system was then secured.

All the thermo-conditioning processes were satisfactorily accomplished, and the system operated to checkout requirements. No FARR's were written during the procedure. The H&CO was revised by variation SEO-001 attached to the drawing. The SEO provided that the R-12 freon bottle would only be installed

4.2.34 (Continued)

when actually used, to guard against a check valve failure that would subject the freon bottle to pressure from the GN_2 supply. The variation SEO revised four paragraphs to effect this change. The system was accepted as secured for shipment.

4.3 Propellant Tanks System Leak Test (A659-1B65763-1PATP6)

Subsequent to the removal of the stage from the VCL tower on 13 April 1967, this prodcution acceptance test procedure was performed to establish the leak-free condition of the propellant tanks assembly. The leak test was conducted, in VCL tower 8, prior to the final inspection of the stage.

Preliminary to this procedure, setup and hookup test A659-61808-PATP3 was conducted on 16 and 17 April 1967. This began with gas samples taken from all lines, to ensure system cleanliness. The installation of all necessary cables and sensors followed, as modified by the following three revisions:

a. One changed the reference location for the hookup of the continuous gas shutoff valve, from 403W8P31 to 403W2P31.

b. One revision noted that a listed connection applied to SIVB/IB stages only.

c. The third revision added a note to this section, to state that all listed cable connections applied to all stages unless otherwise specified.

These were the only revisions to the hookup procedure.

The sensor and cable installation was followed by installation of adapters, and hookup of all lines. Protective caps and the desiccant assembly were removed. The preliminary setup procedure was accepted by Engineering on 3 May 1967.

On 17 April 1967, the tanks leak check was begun. The first step was to verify the system setup per the above procedure. The tanks were pressurized with gaseous helium, to permit the use of the USON leak detector in establishing their integrity. The LOX and LH_2 tank integrity pressure was 12 $\pm$ 0.5 psig, while the tanks leak check pressure was 10 $\pm$ 0.5 psig, to be pressurized in 5 psi increments. The gas flow control valve was checked by

4.3 (Continued)

closing it at several points, and monitoring tank pressures. All tank pressure measurements were within tolerance. The GH_2 and GO_2 exhaust valves were then opened and closed to verify their operation.

The GHe concentration in both tanks was measured, in order to verify that the gas content was at least fifty per cent GHe. The results of this check appear in Table 4.3.1. The USON leak detector and bubble fluid were checked to ensure the accuracy of these leak detection methods. The LOX and LH_2 tank pressure gages were monitored throughout the test, and it was required that any pressure decrease of greater than 0.5 psig be reported.

The following areas in the LOX system were checked by the USON leak detector method for any leakages in excess of 0.001 cubic centimeters per second: the LOX tank to prevalve connection; the feed line from the prevalve to the engine interface, including transducers C004 and D003; the chilldown line from chilldown pump to prevalve; the chilldown return line from the engine interface to the tank; the fill and drain line from aft umbilical disconnect to tank; the vent line from tank to aft skirt; the sense lines from tank to transducers D180, D179, and D577 (including hand valve, P/N 1B53817); the pressurization line from tank to pipe assembly, P/N 1B55285-1; the tank wiring feedthrough assembly; the instrumentation feedthrough assembly; and the PU probe feedthrough assembly. All of the above lines met the standard of 10^{-3} cc/sec leakage, except for the LOX chilldown return line. Excessive leakage in this area was recapped on the Leak Check Record Sheet, and later on FARR A228592.

A flowmeter was used to verify that the LOX fill and drain valve and prevalve shaft seal leakage, and the LOX chilldown pump cavity seal leakage,

4.3 (Continued)

were less than 100 scim. In addition, it was confirmed that the relief valve housing static seal leakage was less than 1 scim, and that the vent and relief valve from pilot valve cap to duct leakage did not exceed 80 scim.

The USON detector was next employed to verify that the following areas in the LH_2 system did not leak in excess of 0.001 cubic centimeters per second: the feed line from tank to prevalve; the feed line from prevalve to engine interface, including transducers C003 and D002; the LH_2 chilldown and return lines from pump to prevalve, and from engine interface to tank; the fill and drain line from aft umbilical disconnect to tank; the vent lines from tank to directional control valve; the vent line from directional control valve to forward umbilical disconnect; the vent line from directional control valve to the capped ends of nonpropulsive and continuous vent systems; sense lines from tank to transducers D576, D177, and D178; the pressurization line from tank to pipe assembly, P/N 1B43397-1, and the PU probe feedthrough assembly; the cover plate; and the tank to cold helium bottle connections. Of the above noted areas, only in the chilldown and chilldown return lines was leakage noted in excess of 10^{-3} cc/sec. This condition was recapped to the Leak Check Record Sheet, and later to FARR A228592.

The flowmeter was used to check the LH_2 system valves leakage as follows: fill and drain valve and prevalve shaft seal leakage was verified less than 100 scim; directional control valve shaft seal leakage was checked less than 5 scim; LH_2 relief pilot valve seals and vent valve static seals leakage was determined to be less than 40 scim; the relief valve static seal leakage was determined to be less than 1 scim; the continuous vent control module leakage was found to be less than 80 scim; and the chilldown pump housing seal leakage was verified less than 25 scim.

4.3 (Continued)

The vent and non-propulsive vent valves were closed, the sample bleed valve was opened, the directional control valve was set to "flight," and the continuous vent valve was set to "relieve." The sample port leakage was measured with a flowmeter, and was found to be less than 330 scim. With the closing of both systems fill and drain and vent valves, the leak test was completed.

The leak check was rerun on 18 April 1967, after the leakages found on the first run had been resolved by replacing fitting seals (FARR A228592). This time there were no leaks and the test proceeded to completion.

A disconnect and tank securing procedure was then followed. The desiccant unit was installed; all lines were removed, valves were closed, and protective caps were replaced. The helium bleed valve was opened, and the system was allowed to bleed to ambient (unmeasurable GHe concentration). All switches were turned off.

The leak check record sheet noted the three leakage conditions noted above: the LOX chilldown return line, P/N 1A87736-1; the LH_2 chilldown line, P/N 1B49966-501; and the LH_2 chilldown return line, P/N 1B59760-1 were found to have leakage in excess of 10^{-3} cc/sec, when tested using the USON leak detector. These problems were recapped to FARR A228592, and were resolved, per this FARR, by replacing seals. No other leakages or failure and rejection reports were noted.

Six items were changed according to revisions appearing in the Quality Engineering documentation log sheet:

4.3 (Continued)

a. One revision changed the part number of the pipe assembly to which the LOX pressurization line was connected, from 1B52832-1 to 1B55285-1.

b. A revision deleted the check of the connection of the LH_2 sense line going through transducer D178 to hand valve, P/N 1B53817. The hand valve connection itself had been deleted.

c. A revision modified the callout for the leak check of the LH_2 tank to cold helium bottles connection. The note "at six places" was deleted.

d. Revisions four and five deleted several instructions in the retest portion of the procedure, as they had already been accomplished satisfactorily.

e. The final revision specified that the D54 transducer be connected, test equipment be reconnected, and the LH_2 tank be pressurized to 5 psig and repressurized to 10 psig while monitoring test equipment, at the conclusion of the retest. This was done to check out the test equipment.

4.3.1 Test Data Table, Propellant Tanks Leak Test

Gaseous Helium Concentration Prior to USON Leak Tests (S/B greater than 50 per cent)

Location	GHe Concentration (per cent)
LOX Fill and Drain Line	57.5
LOX Chilldown and Chilldown Return Lines	58.5
LH_2 Tank Non-Propulsive Vent Line	100.0
LOX Tank Vent Port	100.0
LOX Tank Monitor Port	100.0
LH_2 Chilldown and Chilldown Return Lines	76.6
LH_2 Fill and Drain Line	79.8
LOX Chilldown Return Line (Retest)	90.7
LH_2 Chilldown Return Line (Retest)	63.0

4.4 Final Inspection

After the completion of stage acceptance testing and final manufacturing operations, a final inspection was conducted on all stage mechancial and electrical areas to locate and correct any remaining discrepancies, and to verify that the stage was in satisfactory condition for the preshipment operations and transfer to STC. This final inspection was conducted between 22 and 25 May 1967, and the results and necessary rework were accepted on 9 June 1967.

Altogether, 121 defects were found. Of these, eighty-five were of an electrical nature, and thirty-six were mechanical. The electrical discrepancies included loose or tight clamps, damaged wires or connectors, broken or missing parts, connectors improperly stowed, terminals improperly served, and wrong or missing identification. Those defects which were mechanical in nature included dents, chipped paint, items improperly safety wired, lack of torquing, missing parts, and lack of identification.

Most of these discrepancies were resolved immediately. However, three defects were recapped to failure and rejection reports for correction:

a. FARR A257902 noted that there was no evidence that relay control package 404A51A4, P/N 1B57731-1, S/N 337, had been acceptance tested. No test data per B/P 1B53606 was on file. The attaching hardware was removed, and the faying surface was checked for buyout stamps. The package was found to have been tested acceptably, and was accepted for use.

b. FARR A261104 reported that there was a sharp dent in tube 164 on the J-2 engine, P/N 103826, S/N J-2094. The dent, located 2 inches below hatband 6, measured 0.038 inches in depth. The dented area was brazed to an acceptable condition by Rocketdyne personnel.

c. FARR A261105 noted that standoff, P/N 1B37428-513, was broken off of panel, P/N 1B58924-1, at stringer 59 of the aft skirt. Also at stringer 98, station 200, one excess 3/16 inch hole was drilled through bracket, P/N 1B52940-1. Both defects were accepted by Engineering for use.

4.5 Weight and Balance

On 9 June 1967, the stage was prepared for the horizontal weight and balance operation, and the stage shipping and handling weight, weight at Standard Gravity in a vacuum, and longitudinal center of gravity were determined. The stage was then installed on its transporter for final pre-shipment preparations and the weight and balance procedure.

4.5.1 Stage Weigh and Balance Preparation, Horizontal (1B37831 D)

This procedure prepared the stage for the horizontal weight and balance operation, and loaded the stage onto its transporter following this operation. In addition to the stage, the procedure utilized the stage handling kit, P/N 1B37717-1, and the engine protective and dummy interstage support kit, P/N 1B57202-1. The pre-weighing operations were accomplished on 9 June 1967. The transporter loading was accomplished following the weight and balance operations. The results of the procedure were accepted on 14 June 1967, after the completion of the stage weight and balance, H&CO 1B64539.

For the pre-weighing preparations, a forward support ring, P/N 1A68732-1, and an aft support ring, P/N 1A68731-1, were obtained from the stage handling kit, and the weights of the items were verified. With the stage installed vertically in the VCL, the forward support ring was positioned over the forward skirt interface, and attached to the stage. The stage was hoisted clear of the tower, and the aft support ring was attached. An area in the VCL was prepared for the weighing operation, and the weighing cradles, P/N 1A68719-1, were set up. The stage was rotated to a horizontal position, installed in the weighing cradles, and leveled. The forward support assemblies, P/N 1A93715-1 and -2, the forward tripod jack assemblies, P/N 1A98077-1, and the aft jack assembly, P/N 1A93232-1, were installed to complete the pre-weighing preparations.

After the weight and balance operations were completed, the jack and support

4.5.1 (CONTINUED)
assemblies were removed, and the cradles were attached to the forward and aft support rings. The stage support assembly (engine protective cover), P/N 1A71655-1, was installed and attached to the aft support ring.

There were no part shortages during this procedure. No problems were encountered, and no revisions were written to the procedure. After the satisfactory completion of this procedure, the stage was accepted for the final pre-shipment preparations.

4.5.2 Weight and Balance Procedure (1B64539 C)

This procedure measured the weight of Stage 504N with an accuracy of ± 0.1 per cent, and determined the longitudinal center of gravity of the stage. The measured stage weight was corrected for local gravity and air buoyancy forces to determine the weight at Standard Gravity in a vacuum. The procedure was satisfactorily accomplished and accepted on 9 June 1967, following the weigh and balance preparations of H&CO 1B37831.

Before starting the weighing operation, the electronic weighing system, P/N 1A57907-1, was set up and calibrated. Three load cell assemblies, P/N CMU-1204 or 1B38965-1 and -501, were connected to the load cell readout indicator, P/N CMU-1204, checked for linearity and stability by the use of the indicator standardizer, and adjusted for a zero setting. The stage was verified to be level within 0.250 inches over the axial distance between stations 554.702 and 286.147. The dry bulb temperature, barometric pressure and relative humidity were measured in the weighing area, for use in determining the air density. These measurements were repeated every half hour throughout the weighing operation. Using the hand pumps on the aft jack, P/N 1A93232-1, and the two forward glide-aire jacks, P/N 1A83320-1, the stage was raised to just clear the cradles, and leveled to the previous limit. Regulator air pressure was applied to the forward glide-aire jacks to permit self-adjustment of the stage, and the stage levelness was reverified. After allowing 10 minutes for load cell creep stabilization, load cell readings were taken as shown in Test Data Table 4.5.2.1. The stage was then lowered back onto the cradles, the load cells were allowed to creep stabilize again, and the load cell zero was rechecked

4.5.2 (CONTINUED)

and adjusted if necessary. The weighing procedure was repeated three times, and the average reading for each load cell was determined and corrected for calibration. From the capacity of each load cell, and the load cell reading, the reaction force on each load cell was determined. These reaction forces were then used to determine the stage shipping and handling weight, the stage weight at Standard Gravity in a vacuum, and the longitudinal center of gravity. As shown in the Test Data Table, the stage shipping and handling weight was 26,335.4 pounds, the weight at Standard Gravity in a vacuum was 26,397.8 pounds, and the longitudinal center of gravity was at station 328.12.

No parts were short during this procedure, no revisions were written, and no problems were encountered.

Following the completion of the weight and balance procedure, the stage was accepted for loading on the transporter per H&CO 1B37831, and final preshipment operations.

4.5.2.1 Test Data Table, Weight and Balance Procedure

Air Density Data

Time	Barometric Press. (in. Hg)	Relative Humidity (%)	Dry Bulb Temp.(°F)
10:00	29.890	63.5	66.0
10:30	29.900	62.5	70.0
11:00	29.910	61.5	71.0
11:30	29.908	60.5	72.0
12:00	29.905	58.0	73.0

Calculated Air Density: 0.0743 pounds per cubic foot.

Load Cell Collected Data

Reaction Load Cell	Aft (R1)	Forward (R2)	Forward (R3)
Serial Number	36247	34186	34182
Capacity (pounds)	25,000	10,000	10,000
Run 1 Reading (%)	78.229	36.509	38.769
Run 2 Reading (%)	78.250	36.507	38.736
Run 3 Reading (%)	78.262	36.505	38.697
Average Reading (%)	78.247	36.507	38.734
Calibration Correction	0.886	0.196	0.220
Corrected Reading (%)	79.134	36.703	38.954
Reaction (pounds)	19,783.5	3,670.3	3,895.4

Weight Determination (pounds)

Aft Reaction R1	19,783.5
Forward Reaction R2	3,670.3
Forward Reaction R3	3,895.4
Total Reactions as recorded	27,349.2

4.5.2.1 (CONTINUED)

Total Reactions as Recorded	27,349.2
Minus Weighing Equipment "Tare"	-1,013.8
Shipping and Handling Weight	26,335.4
Plus Gravitational Correction	+ 29.2
Plus Buoyancy Correction	+ 33.2
Weight at Standard Gravity in a Vacuum	26,397.8

Longitudinal Center of Gravity

Reaction R1 Moment at Sta. 189.3	3,745,016.55
Reaction R2 Moment at Sta. 684.0	2,510,485.20
Reaction R3 Moment at Sta. 684.0	2,664,453.60
Moment Sum	8,919,955.35
Tare Moment	- 278,870.75
Moment Sum Less Tare	8,641,084.60

As Weighed Center of Gravity = Station 328.12

(Moment Sum Less Tare divided by Total Reactions Less Tare)

4.6 GN_2 - Electrical Air Carry Preshipment Purge (1B65783 F)

The final operation before stage shipment was the preshipment purge. This procedure purged the stage with gaseous nitrogen to a dewpoint of -30°F (235 ppm by volume), and installed the necessary desiccants for stage air carry shipment. The desiccant assembly maintained a clean, dry, and safe differential pressure environment during air transportation. The procedure was satisfactorily performed on 12 and 13 June 1967, and was accepted on 14 June 1967.

The purge began with the installation of the LOX and LH_2 desiccant support assemblies, P/N's 1B61272-1 and 1B61270-1. The LOX bellows, P/N 1A49971-501, were removed for separate shipment with the stage. The LOX and LH_2 fill and drain vent covers, the LH_2 non-propulsive vent covers, the LH_2 ground vent cover, and the LOX propulsive vent cover were then installed.

The four LH_2 tank desiccant breathers, P/N 1A79691-501, and the LOX tank desiccant breathing assembly, P/N 1A79691-1, were prepared, filled with desiccant materials, and installed.

Purge unit, P/N 1B61117-1, Model 1865, was prepared and hooked up to the stage. The LH_2 pressurization line, the LOX and LH_2 engine systems, the propellant tanks, the LH_2 ground vent, the LOX propulsive vent, and the LOX and LH_2 tanks were purged with gaseous nitrogen. The final dewpoints attained were -37°F for the LH_2 system, and -38°F for the LOX system. The purge unit was then disconnected and secured.

The final operation in the preshipment air carry purge was the installation of the forward skirt dust cover, P/N 1B61099-1, and the aft skirt dust cover,

4.6 (CONTINUED)

P/N 1B61077-1.

Ten revisions were made to the procedure during the course of testing:

a. Three revisions deleted the O_2H_2 burner desiccant system installations, and the O_2H_2 burner LH_2 duct purge, as the burner had been shipped to STC separately for testing.

b. Two revisions changed the Stage Valve Pneumatic System Connection figure, because pipe assembly, P/N 1B64165-1, had been changed to pipe assembly, P/N 1B65099-1.

c. One revision added an instruction to open the main purge shutoff valve at the start of the LOX system purge.

d. Three revisions gave detailed instructions for manually actuating the LH_2 line purge valve, because the electrical system would not function the valve.

e. One revision changed the document configuration sheet to reflect the actual status of the pages in the H&CO.

There was one failure and rejection report prepared. FARR A257907 was written to note that when the LH_2 vent switch was actuated through a GSE command, a fuse blew, indicating a possible short circuit. Investigation was underway at the time of turnover to determine whether the short was in the GSE or stage wiring. The FARR was open at the time of turnover.

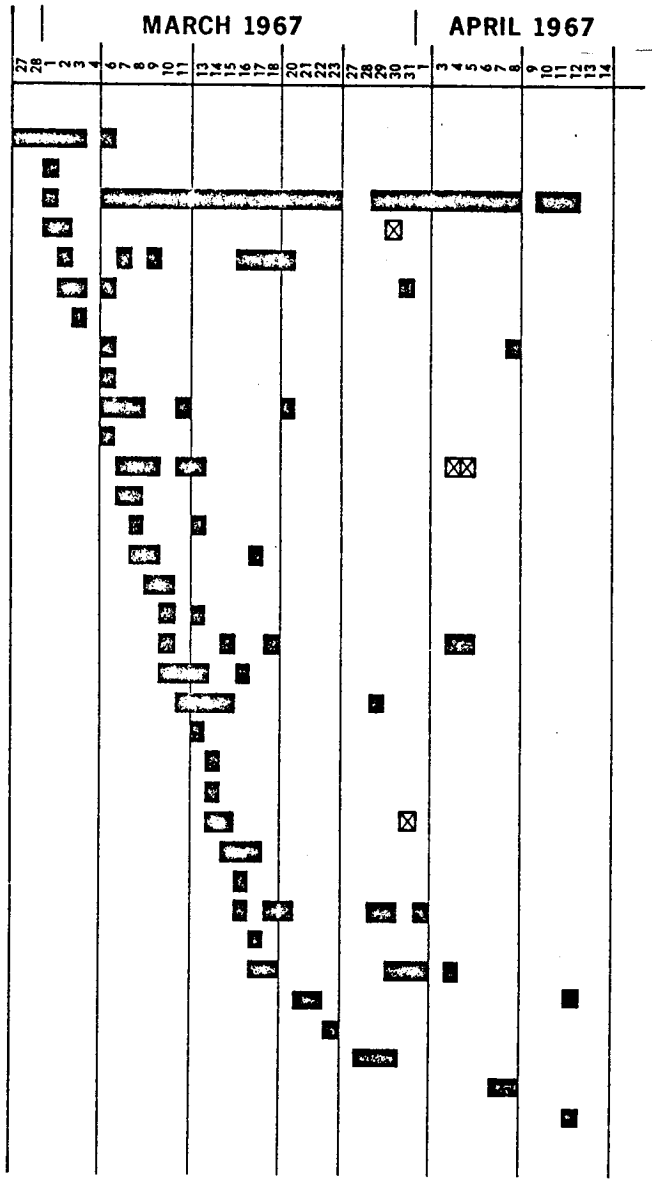
APPENDIX I

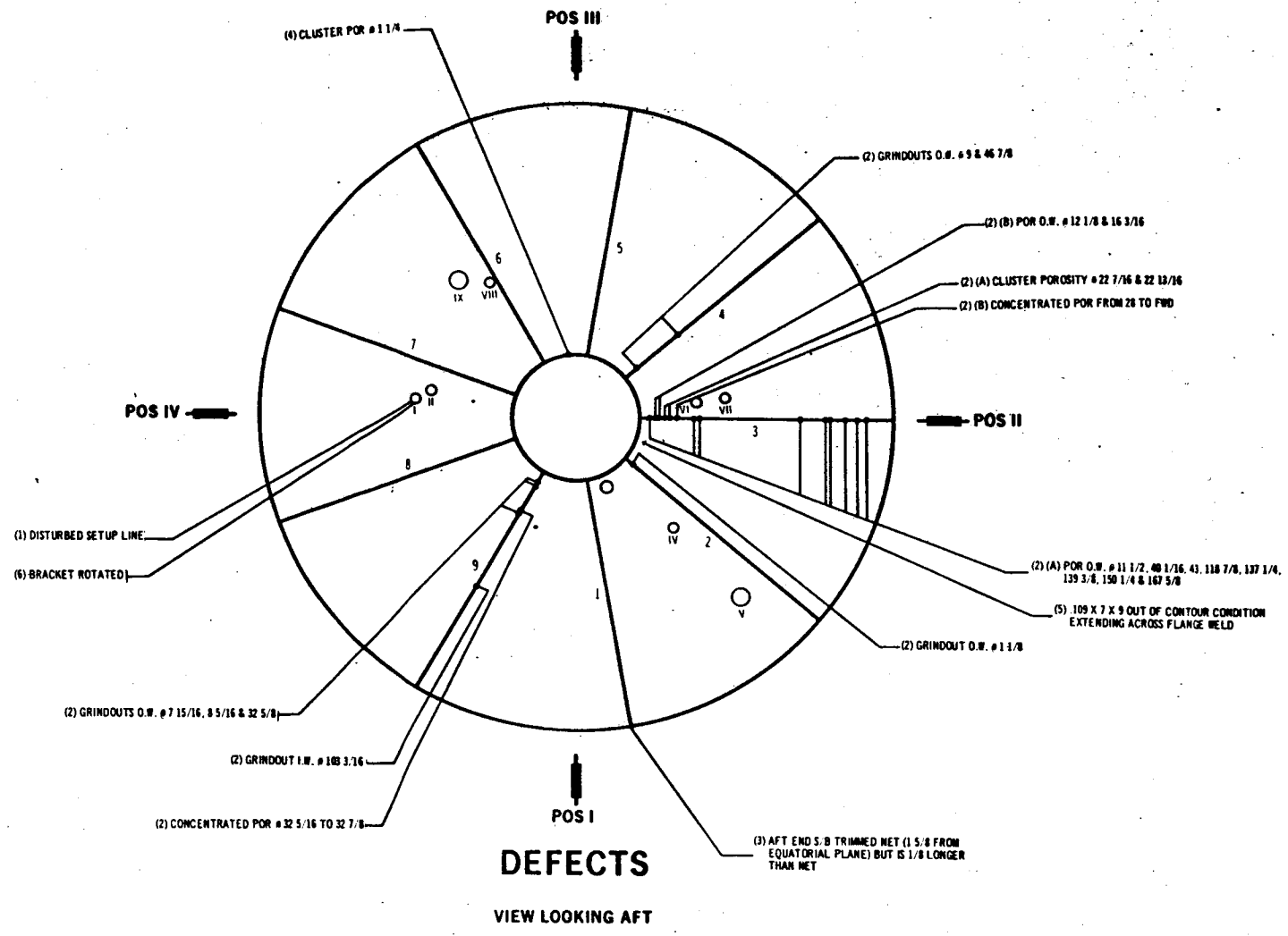
TESTING SEQUENCE

504N SSC VCL TESTING SEQUENCE

PARA.		PROCEDURE
4.2.1	1B59780,	CONTINUITY COMPATIBILITY CHECK
4.2.2	1B41926,	FWD. SKT. T/C CHECKOUT PROCEDURE
4.2.3	1B42124,	FWD. SKT. T/C OPER. PROCEDURE
4.2.4	1B64678,	CRYOGENIC TEMP. SENSOR VERIF.
4.2.5	1B64679,	TM AND RS ANTENNA SYSTEM
4.2.6	1B59782,	UMBILICAL INTERFACE COMPAT. CHECK
4.2.7	1B39126,	ENGINE ALIGNMENT PROCEDURE
4.2.8	1B66560,	STAGE POWER SETUP
4.2.9	1B66561,	STAGE POWER TURNOFF
4.2.10	1B64681,	SIGNAL CONDITIONING SETUP
4.2.11	1B64680,	LEVEL SENSOR AND CONTROL UNIT CALIB.
4.2.12	1B66563,	DDAS CALIBRATION
4.2.13	1B40544,	AFT SKT. AND INTERSTAGE PURGE
4.2.14	1B59454,	PROP. SYST. CONTROL CONSOLE CHECK
4.2.15	1B59455,	PROP. COMP. INTERNAL LEAK CHECK
4.2.16	1B59456,	LH_2 TANK PRESS. SYST. LEAK CHECK
4.2.17	1B66562,	POWER DISTRIBUTION SYSTEM
4.2.18	1B66564,	DDAS AUTOMATIC
4.2.19	1B59458,	COLD HELIUM SYSTEM LEAK CHECK
4.2.20	1B59457,	PNEU. CONTROL SYSTEM LEAK CHECK
4.2.21	1B64367,	PU SYSTEM CALIBRATION
4.2.22	1B66566,	EBW SYSTEM AUTO. CHECKOUT
4.2.23	1B66569,	APS (SIMULATOR) AUTO. CHECKOUT
4.2.24	1B66567,	PU SYSTEM AUTO. CHECKOUT
4.2.25	1B59461,	J2 ENGINE SYSTEM LEAK CHECK
4.2.26	1B66565,	RANGE SAFETY RECEIVER AUTO. CHECK
4.2.27	1B59459,	PROP. TANK SYSTEM LEAK CHECK
4.2.28	1B66568,	RANGE SAFETY SYSTEM AUTO. CHECK
4.2.29	1B66572,	PROPULSION SYSTEM TEST
4.2.30	1B40973,	HYD. SYST. FILL, FLUSH, BLEED
4.2.31	1B66570,	HYDRAULIC SYSTEM AUTO. CHECK
4.2.32	1B59460,	REPRESS. SYSTEM LEAK CHECK
4.2.33	1B66571,	ALL SYSTEMS TEST
4.2.34	1B62965,	FWD. SKT. T/C POST CHECKOUT PROC.

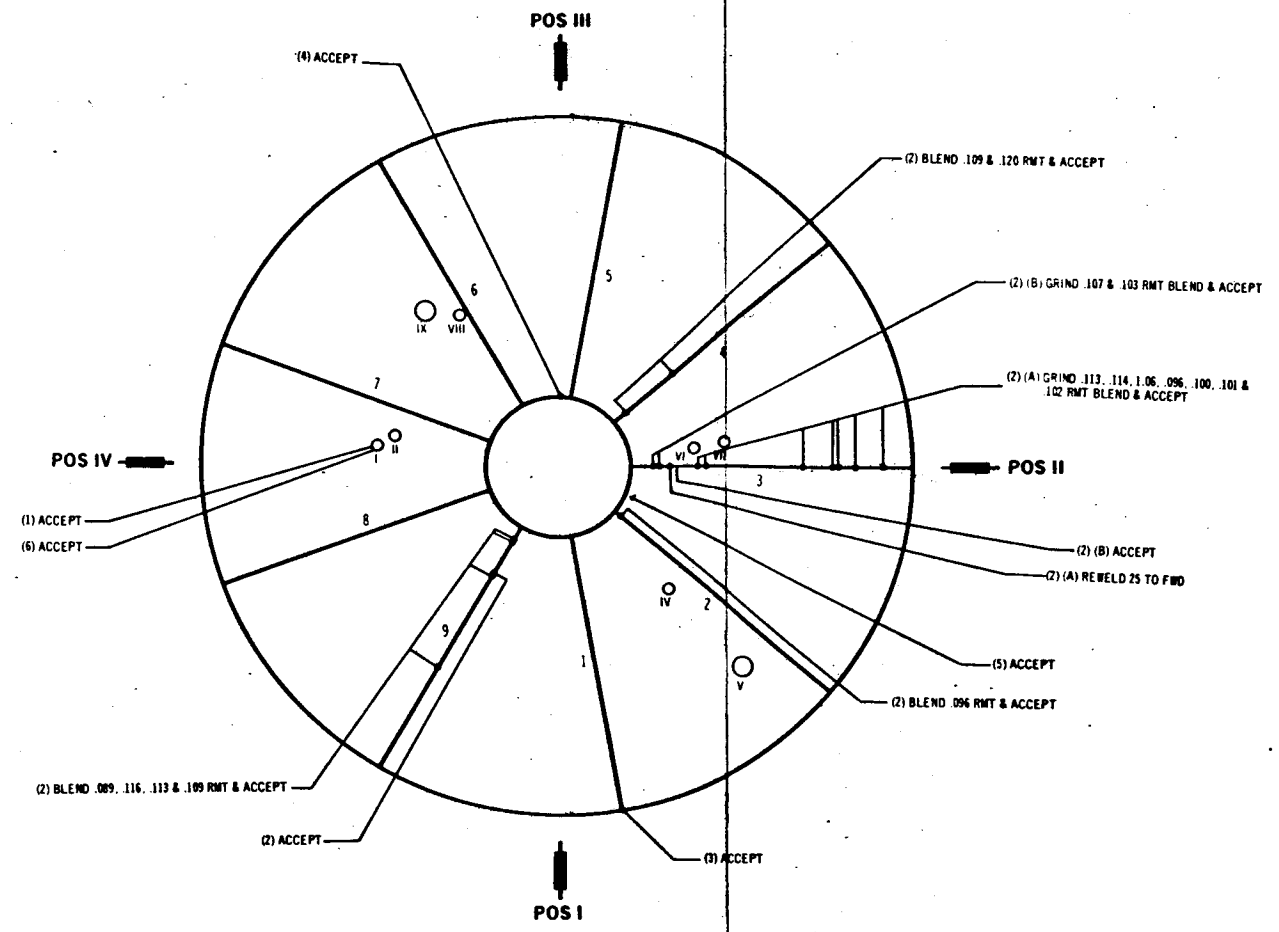
⊠ INDICATES SECOND ISSUE.




POS III
POS IV
POS II
POS I
(4) CLUSTER POR ø 1 1/4
(2) GRINDOUTS O.W. ø 9 & 46 7/8
(2) (B) POR O.W. ø 12 1/8 & 16 3/16
(2) (A) CLUSTER POROSITY ø 22 7/16 & 22 13/16
(2) (B) CONCENTRATED POR FROM 28 TO FWD
(1) DISTURBED SETUP LINE
(6) BRACKET ROTATED
(2) (A) POR O.W. ø 11 1/2, 48 1/16, 43, 118 7/8, 137 1/4, 139 3/8, 150 1/4 & 167 5/8
(5) .109 X 7 X 9 OUT OF CONTOUR CONDITION EXTENDING ACROSS FLANGE WELD
(2) GRINDOUT O.W. ø 1 1/8
(2) GRINDOUTS O.W. ø 7 15/16, 8 5/16 & 32 5/8
(2) GRINDOUT I.W. ø 103 3/16
(2) CONCENTRATED POR ø 32 5/16 TO 32 7/8
(3) AFT END S.B TRIMMED NET (1 5/8 FROM EQUATORIAL PLANE) BUT IS 1/8 LONGER THAN NET

DEFECTS

VIEW LOOKING AFT

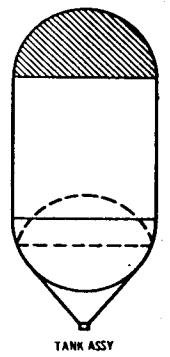

POS III
POS IV
POS II
POS I
(4) ACCEPT
(2) BLEND .109 & .120 RMT & ACCEPT
(2) (B) GRIND .107 & .103 RMT BLEND & ACCEPT
(2) (A) GRIND .113, .114, 1.06, .096, 100, .101 & .102 RMT BLEND & ACCEPT
(1) ACCEPT
(6) ACCEPT
(2) (B) ACCEPT
(2) (A) REWELD 25 TO FWD
(5) ACCEPT
(2) BLEND .096 RMT & ACCEPT
(2) BLEND .089, .116, .113 & .109 RMT & ACCEPT
(2) ACCEPT
(3) ACCEPT

REWORKS

VIEW LOOKING AFT

LEGEND

I BRACKET TEE
II INSTR LEAD OUT WIRE PORT
III VENT SEPARATOR
IV CLIP LH VENT LINE
V VENT LINE PORT
VI PRESS SENSOR
VII PRESS PORT
VIII BRACKET TEE
XI P U WIRE LEAD OUT PORT

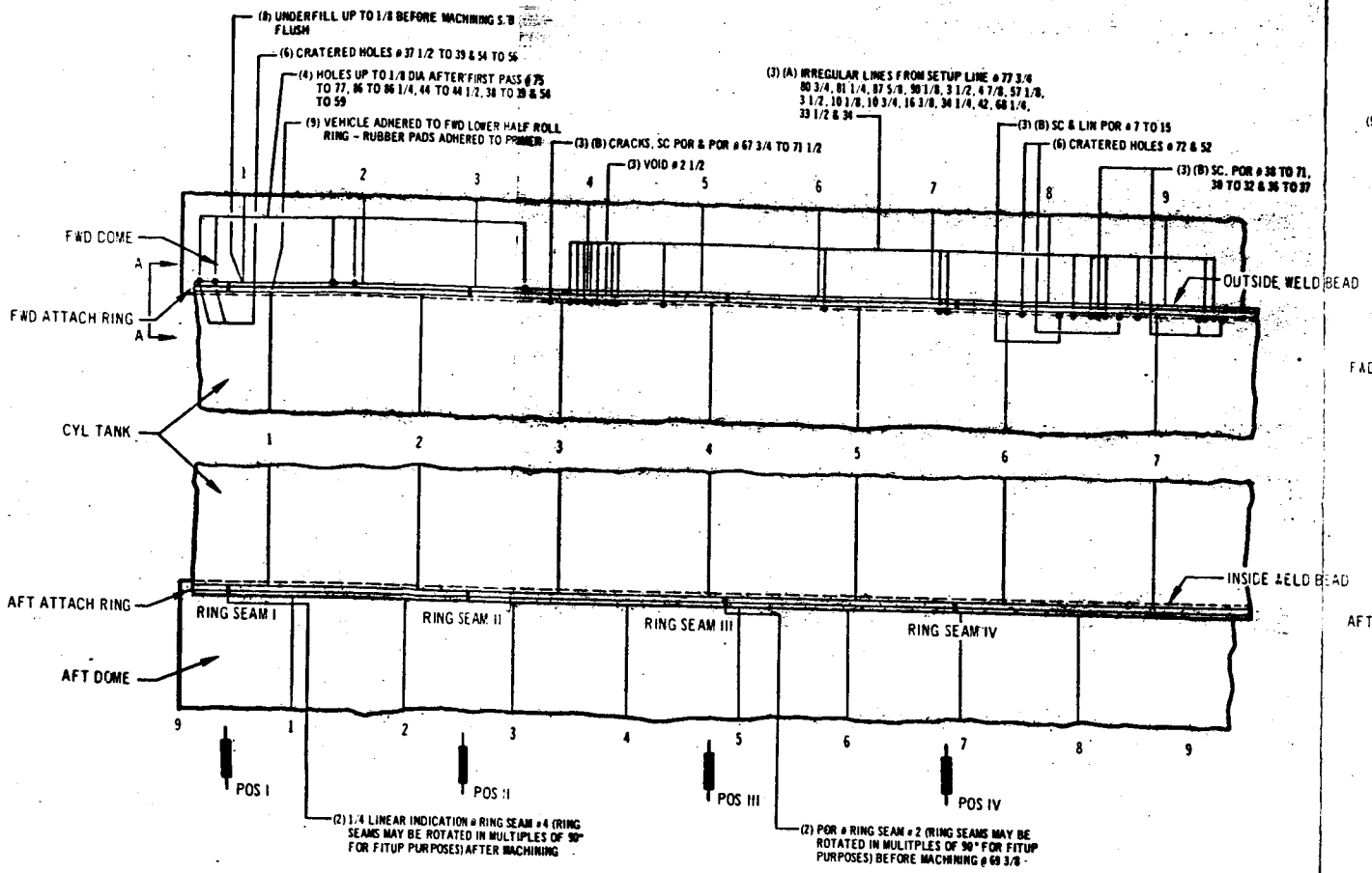


TANK ASSY

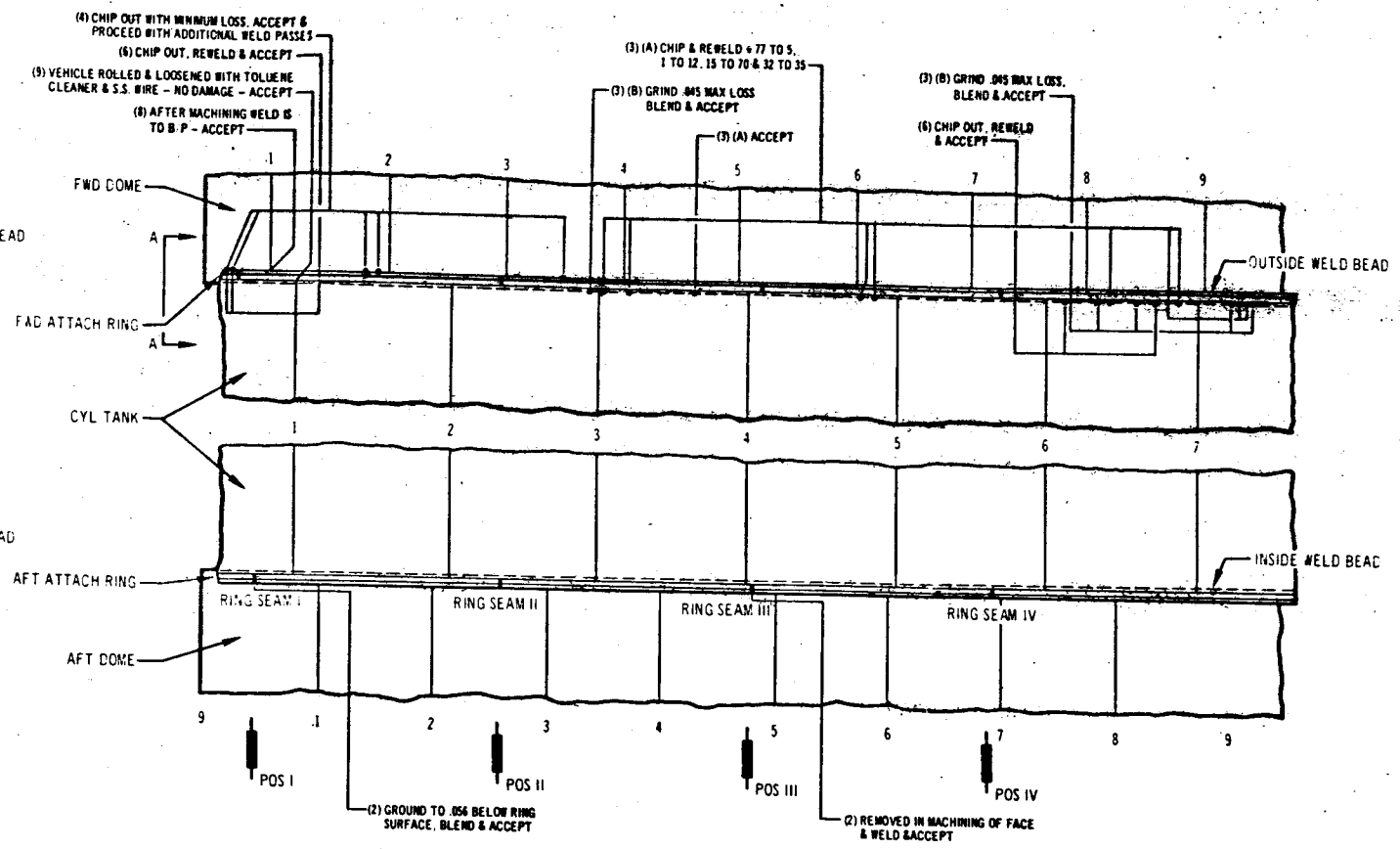
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	HOW REWORKED	REWELDS
1	A206810 AE	7-29-66	1	0	N/A	0
2	A206831 MER	8-9-66	21	17	AUTO MIG	1
3	A206884	8-12-66	1	0	N/A	0
4	A206944 FLANGE	8-17-66	1	0	N/A	0
5	A206892	8-18-66	1	0	N/A	0
6	A206897 AE	8-20-66	1	0	N/A	0

ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS

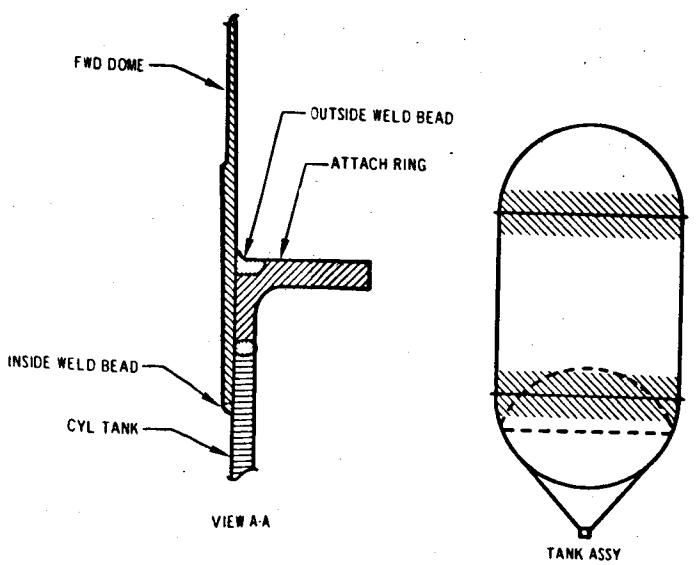
Chart 1. Forward Dome Assembly


(8) UNDERFILL UP TO 1/8 BEFORE MACHINING S.B. FLUSH
(6) CRATERED HOLES ø 37 1/2 TO 39 & 54 TO 56
(4) HOLES UP TO 1/8 DIA AFTER FIRST PASS ø 75 TO 77, 86 TO 86 1/4, 44 TO 44 1/2, 38 TO 39 & 54 TO 59
(9) VEHICLE ADHERED TO FWD LOWER HALF ROLL RING - RUBBER PADS ADHERED TO PRIMER
(3) (B) CRACKS, SC POR & POR ø 67 3/4 TO 71 1/2
(2) VOID ø 2 1/2
(3) (A) IRREGULAR LINES FROM SETUP LINE ø 77 3/4 80 3/4, 81 1/4, 87 5/8, 90 1/8, 3 1/2, 4 7/8, 57 1/8, 3 1/2, 10 1/8, 10 3/4, 16 3/8, 34 1/4, 42, 68 1/4, 33 1/2 & 34
(3) (B) SC & LIN POR ø 7 TO 15
(6) CRATERED HOLES ø 72 & 52
(3) (B) SC, POR ø 38 TO 71, 38 TO 32 & 36 TO 37
FWD DOME
A
FWD ATTACH RING
A
OUTSIDE WELD BEAD
CYL TANK
AFT ATTACH RING
INSIDE WELD BEAD
RING SEAM I
RING SEAM II
RING SEAM III
RING SEAM IV
AFT DOME
POS I
POS II
POS III
POS IV
(2) 1/4 LINEAR INDICATION ø RING SEAM ø 4 (RING SEAMS MAY BE ROTATED IN MULTIPLES OF 90° FOR FITUP PURPOSES) AFTER MACHINING
(2) POR ø RING SEAM ø 2 (RING SEAMS MAY BE ROTATED IN MULITPLES OF 90° FOR FITUP PURPOSES) BEFORE MACHINING ø 69 3/8

DEFECTS


(4) CHIP OUT WITH MINIMUM LOSS, ACCEPT & PROCEED WITH ADDITIONAL WELD PASSES
(6) CHIP OUT, REWELD & ACCEPT
(5) VEHICLE ROLLED & LOOSENED WITH TOLUENE CLEANER & S.S. WIRE - NO DAMAGE - ACCEPT
(8) AFTER MACHINING WELD IS TO B/P - ACCEPT
(3) (A) CHIP & REWELD ø 77 TO 5, 1 TO 12, 15 TO 70 & 32 TO 35
(3) (B) GRIND .045 MAX LOSS BLEND & ACCEPT
(3) (A) ACCEPT
(3) (B) GRIND .045 MAX LOSS, BLEND & ACCEPT
(6) CHIP OUT, REWELD & ACCEPT
FWD DOME
A
FAD ATTACH RING
A
OUTSIDE WELD BEAD
CYL TANK
AFT ATTACH RING
INSIDE WELD BEAD
RING SEAM I
RING SEAM II
RING SEAM III
RING SEAM IV
AFT DOME
POS I
POS II
POS III
POS IV
(2) GROUND TO .056 BELOW RING SURFACE, BLEND & ACCEPT
(2) REMOVED IN MACHINING OF FACE & WELD &ACCEPT

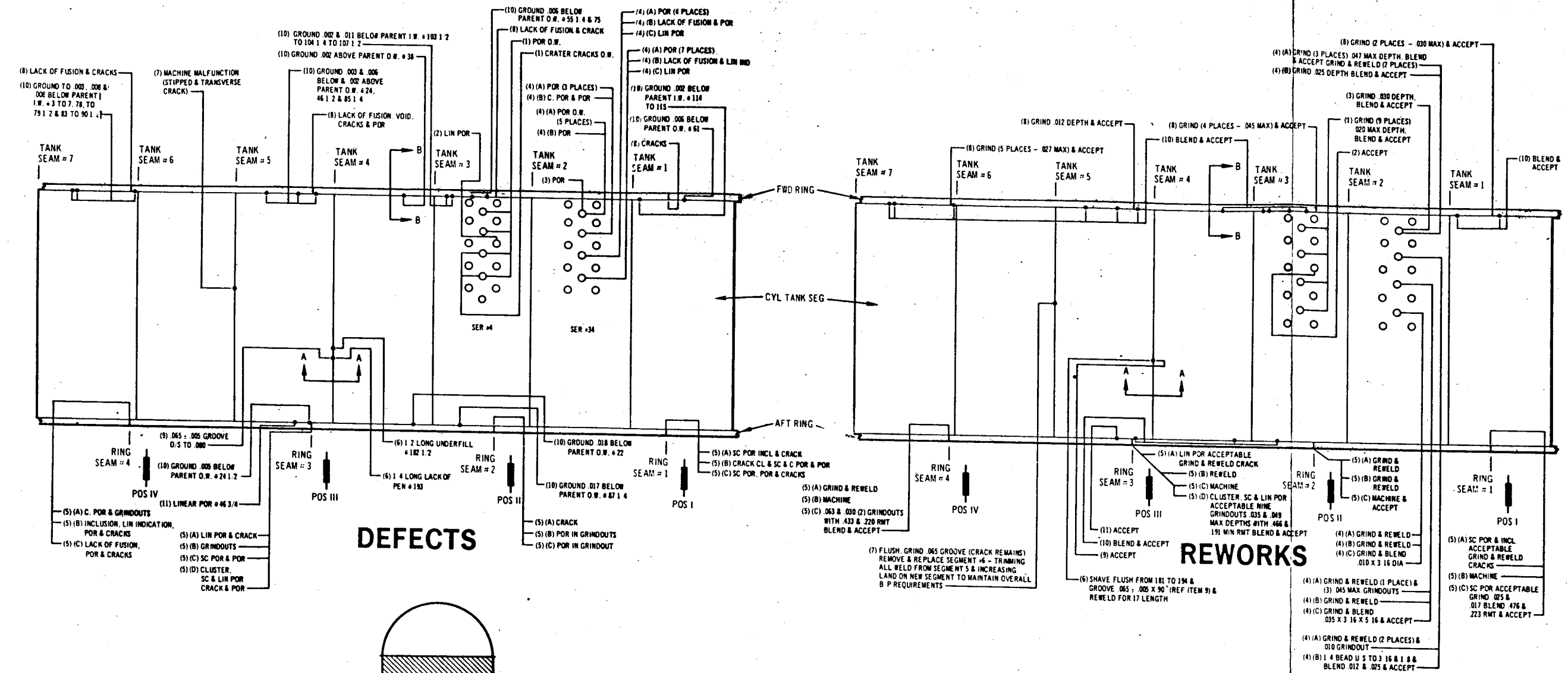
REWORKS

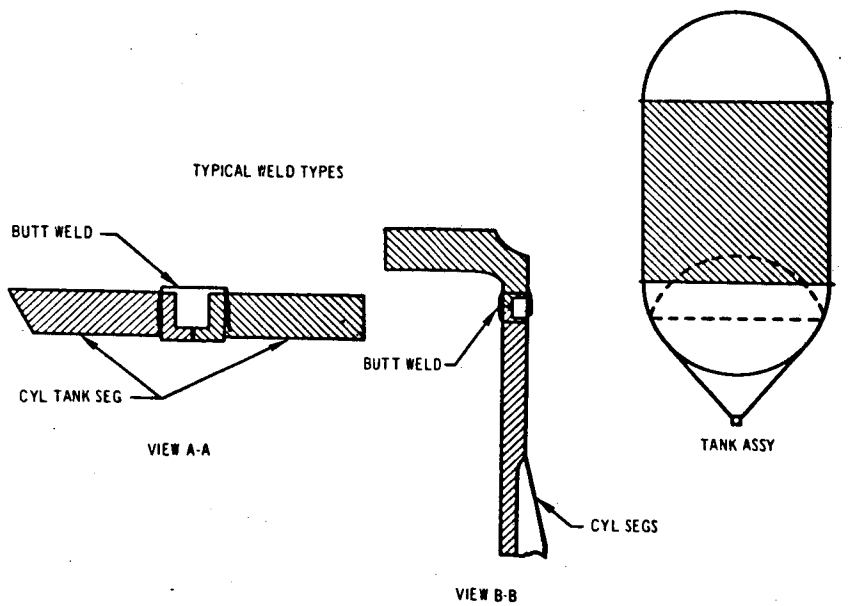


ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS
1	A217190	9-16-66	SEE AFT DOME ITEM (23)			
2	A217194	9-21-66	2	1	N A	0
3	A217196	9-26-66	23	9	AUTO MIG	1
4	A217198	10-1-66	5	5	N A	0
5	A217200	10-3-66	SEE AFT DOME ITEM (24)			
6	A220477	10-4-66	4	4	AUTO MIG	1
7	A220481	10-6-66	SEE AFT DOME ITEM (25)			
8	A220482	10-6-66	1	0	N A	0
9	A220485	10-12-66	1	1	N A	0
10	A220487	10-18-66	SEE COMMON ASSY TO AFT DOME ASSY ITEM (5)			

ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS

Chart 2. Forward Dome and LOX Tank to Cylinder Welds

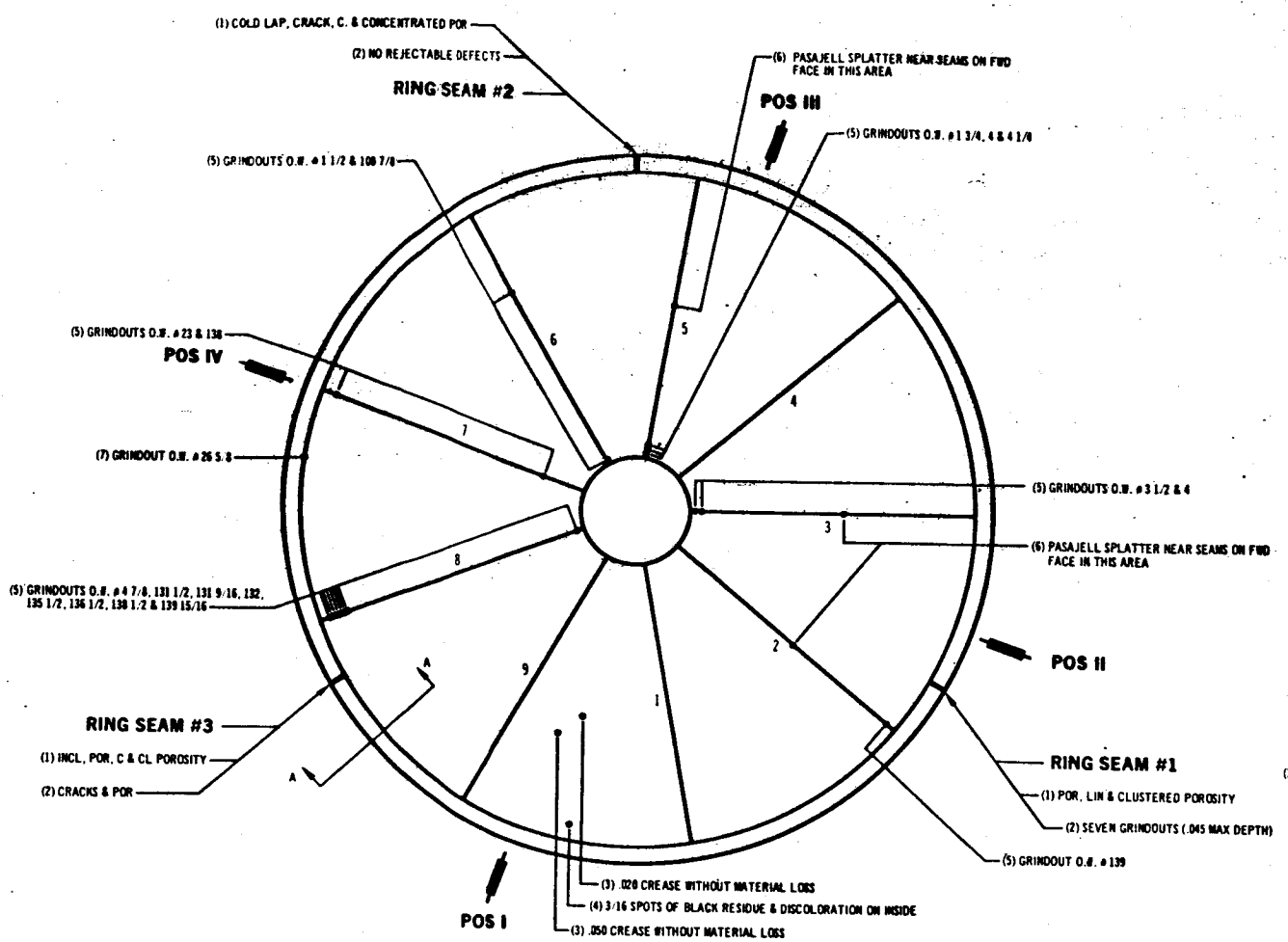

DEFECTS
REWORKS
TANK SEAM # 7
TANK SEAM # 6
TANK SEAM # 5
TANK SEAM # 4
TANK SEAM # 3
TANK SEAM # 2
TANK SEAM # 1
FWD RING
CYL TANK SEG
AFT RING
RING SEAM # 4
RING SEAM # 3
RING SEAM # 2
RING SEAM # 1
POS IV
POS III
POS II
POS I
SER #4
SER #34
(8) LACK OF FUSION & CRACKS
(10) GROUND TO .003 , .006 & .008 BELOW PARENT I.W. # 3 TO 7, 78, TO 79 1 2 & 83 TO 90 1 4
(7) MACHINE MALFUNCTION (STIPPED & TRANSVERSE CRACK)
(10) GROUND .003 & .006 BELOW & .002 ABOVE PARENT O.W. # 24, 46 1 2 & 85 1 4
(8) LACK OF FUSION, VOID, CRACKS & POR
(10) GROUND .002 & .011 BELOW PARENT I.W. # 103 1 2 TO 104 1 4 TO 107 1 2
(10) GROUND .002 ABOVE PARENT O.W. # 38
(2) LIN POR
(10) GROUND .005 BELOW PARENT O.W. # 55 1 4 & 75
(8) LACK OF FUSION & CRACK
(1) POR O.W.
(1) CRATER CRACKS O.W.
(4) (A) POR (3 PLACES)
(4) (B) C. POR & POR
(4) (A) POR O.W. (5 PLACES)
(4) (B) POR
(3) POR
(4) (A) POR (4 PLACES)
(4) (B) LACK OF FUSION & POR
(4) (C) LIN POR
(4) (A) POR (7 PLACES)
(4) (B) LACK OF FUSION & LIN IND
(4) (C) LIN POR
(10) GROUND .002 BELOW PARENT I.W. # 114 TO 115
(10) GROUND .006 BELOW PARENT O.W. # 61
(8) CRACKS
(8) GRIND .012 DEPTH & ACCEPT
(8) GRIND (5 PLACES - .027 MAX) & ACCEPT
(8) GRIND (4 PLACES - .045 MAX) & ACCEPT
(10) BLEND & ACCEPT
(8) GRIND (2 PLACES - .030 MAX) & ACCEPT
(4) (A) GRIND (3 PLACES) .047 MAX DEPTH, BLEND & ACCEPT GRIND & REWELD (2 PLACES)
(4) (B) GRIND .025 DEPTH BLEND & ACCEPT
(3) GRIND .030 DEPTH, BLEND & ACCEPT
(1) GRIND (9 PLACES) .020 MAX DEPTH, BLEND & ACCEPT
(2) ACCEPT
(10) BLEND & ACCEPT
(5) .065 ± .005 GROOVE O/S TO .080
(10) GROUND .005 BELOW PARENT O.W. # 24 1 2
(11) LINEAR POR # 46 3/4
(6) 1 2 LONG UNDERFILL # 182 1 2
(6) 1 4 LONG LACK OF PEN # 193
(10) GROUND .018 BELOW PARENT O.W. # 22
(10) GROUND .017 BELOW PARENT O.W. # 87 1 4
(5) (A) SC POR INCL & CRACK
(5) (B) CRACK CL & SC & C POR & POR
(5) (C) SC POR, POR & CRACKS
(5) (A) GRIND & REWELD
(5) (B) MACHINE
(5) (C) .063 & .030 (2) GRINDOUTS WITH .433 & .220 RMT BLEND & ACCEPT
(7) FLUSH GRIND .065 GROOVE (CRACK REMAINS) REMOVE & REPLACE SEGMENT #6 - TRIMMING ALL WELD FROM SEGMENT 5 & INCREASING LAND ON NEW SEGMENT TO MAINTAIN OVERALL B P REQUIREMENTS
(5) (A) LIN POR ACCEPTABLE GRIND & REWELD CRACK
(5) (B) REWELD
(5) (C) MACHINE
(5) (D) CLUSTER, SC & LIN POR ACCEPTABLE NINE GRINDOUTS .035 & .049 MAX DEPTHS WITH .466 & 191 MIN RMT BLEND & ACCEPT
(11) ACCEPT
(10) BLEND & ACCEPT
(9) ACCEPT
(6) SHAVE FLUSH FROM 181 TO 194 & GROOVE .065 ± .005 X 90° (REF ITEM 9) & REWELD FOR 17 LENGTH
(5) (A) GRIND & REWELD
(5) (B) GRIND & REWELD
(5) (C) MACHINE & ACCEPT
(4) (A) GRIND & REWELD
(4) (B) GRIND & REWELD
(4) (C) GRIND & BLEND .010 X 3 16 DIA
(4) (A) GRIND & REWELD (1 PLACE) & (3) .045 MAX GRINDOUTS
(4) (B) GRIND & REWELD
(4) (C) GRIND & BLEND .035 X 3 16 X 5 16 & ACCEPT
(4) (A) GRIND & REWELD (2 PLACES) & .010 GRINDOUT
(4) (B) 1 4 BEAD U S TO 3 16 & 1 8 & BLEND .012 & .025 & ACCEPT
(5) (A) SC POR & INCL ACCEPTABLE GRIND & REWELD CRACKS
(5) (B) MACHINE
(5) (C) SC POR ACCEPTABLE GRIND .025 & .017 BLEND .476 & .223 RMT & ACCEPT
(10) BLEND & ACCEPT
(5) (A) GRIND & REWELD
(5) (B) GRIND & REWELD
(5) (C) GRIND & REWELD
(5) (D) CLUSTER SC & LIN POR CRACK & POR
(5) (A) LIN POR & CRACK
(5) (B) GRINDOUTS
(5) (C) SC POR & POR
(5) (C) LACK OF FUSION, POR & CRACKS
(5) (B) INCLUSION, LIN INDICATION, POR & CRACKS
(5) (A) C. POR & GRINDOUTS



ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS
1	A212673	5- 9-66	9	9	N A	0
2	A195556	5-13-66	1	0	N A	0
3	A206777	6-28-66	1	1	N A	0
4	A206733	7-5-66	30	18	AUTO TIG	6
5	A206801	7-20-66	48	24	MANUAL MIG	6
6	A203622	7-27-66	2	1	AUTO MIG	1
7	A203625	7-28-66	1	1	AUTO MIG	1
8	A206815	8-4-66	18	13	N A	0
9	A216981 S4	8-4-66	1	0	N A	0
10	A220154 RING #	9-2-66	16	16	N A	0

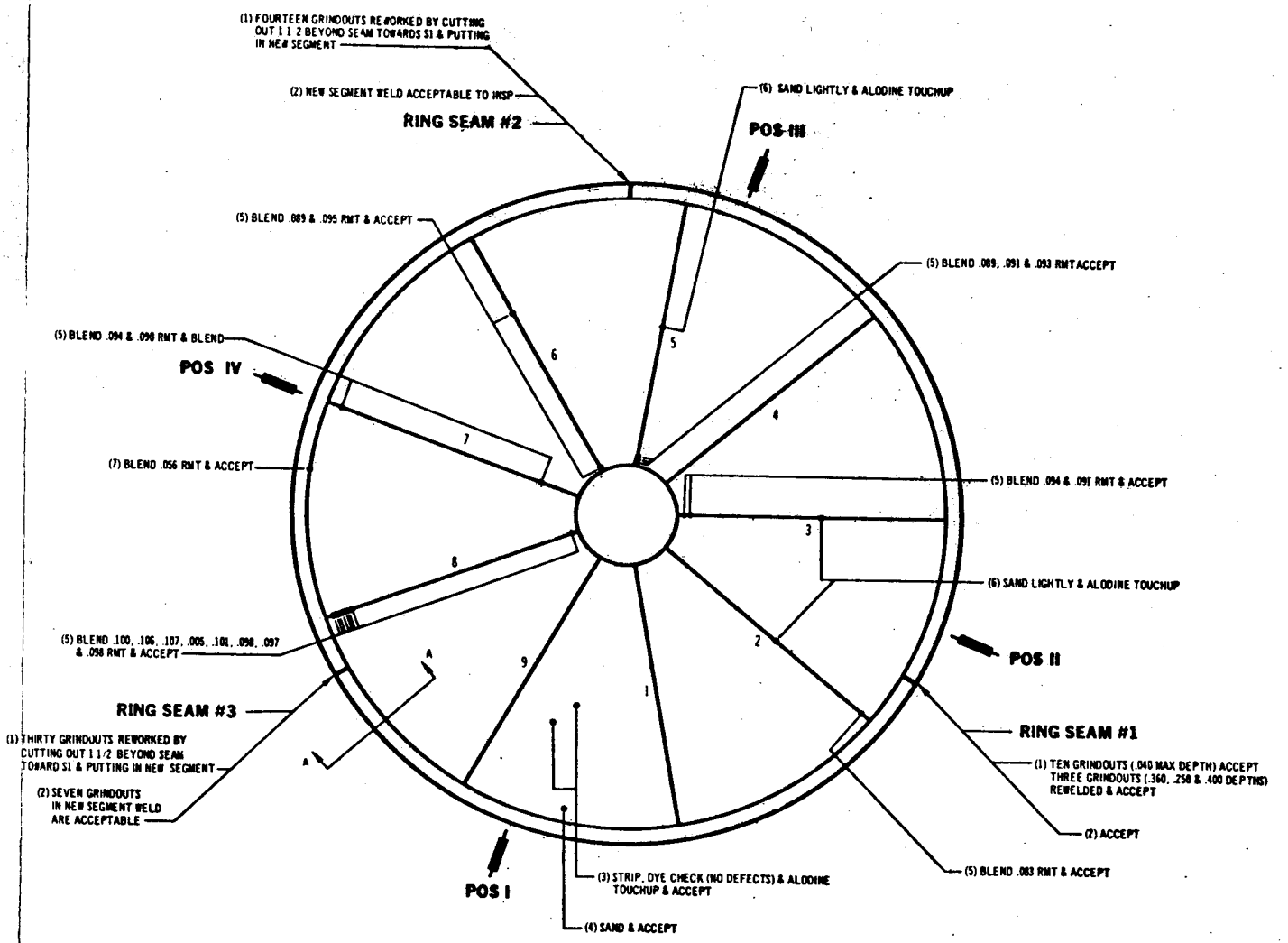
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS
11	A220157 RING #	9-7-66	1	0	N A	0

Chart 3. Cylindrical Tank Assembly


(1) COLD LAP, CRACK, C. & CONCENTRATED POR
(2) NO REJECTABLE DEFECTS
RING SEAM #2
POS III
(6) PASAJELL SPLATTER NEAR SEAMS ON FWD FACE IN THIS AREA
(5) GRINDOUTS O.W. ø 1 1/2 & 108 7/8
(5) GRINDOUTS O.W. ø 1 3/4, 4 & 4 1/8
(5) GRINDOUTS O.W. ø 23 & 138
POS IV
(7) GRINDOUT O.W. ø 26 5.8
(5) GRINDOUTS O.W. ø 3 1/2 & 4
(6) PASAJELL SPLATTER NEAR SEAMS ON FWD FACE IN THIS AREA
(5) GRINDOUTS O.W. ø 4 7/8, 131 1/2, 131 9/16, 132, 135 1/2, 136 1/2, 138 1/2 & 139 15/16
POS II
RING SEAM #3
(1) INCL., POR, C & CL POROSITY
(2) CRACKS & POR
RING SEAM #1
(1) POR, LIN & CLUSTERED POROSITY
(2) SEVEN GRINDOUTS (.045 MAX DEPTH)
(5) GRINDOUT O.W. ø 139
POS I
(3) .020 CREASE WITHOUT MATERIAL LOSS
(4) 3/16 SPOTS OF BLACK RESIDUE & DISCOLORATION ON INSIDE
(3) .050 CREASE WITHOUT MATERIAL LOSS

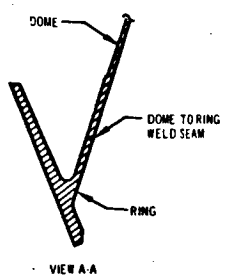
DEFECTS

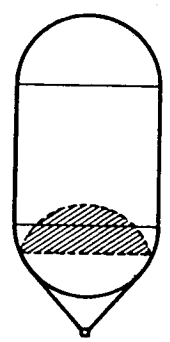
VIEW LOOKING AFT


(1) FOURTEEN GRINDOUTS REWORKED BY CUTTING OUT 1 1/2 BEYOND SEAM TOWARDS S1 & PUTTING IN NEW SEGMENT
(2) NEW SEGMENT WELD ACCEPTABLE TO MSP
RING SEAM #2
POS III
(6) SAND LIGHTLY & ALODINE TOUCHUP
(5) BLEND .089 & .095 RMT & ACCEPT
(5) BLEND .089, .091 & .093 RMT ACCEPT
(5) BLEND .094 & .090 RMT & BLEND
POS IV
(7) BLEND .056 RMT & ACCEPT
(5) BLEND .094 & .091 RMT & ACCEPT
(6) SAND LIGHTLY & ALODINE TOUCHUP
(5) BLEND .100, .106, .107, .005, .101, .098, .097 & .058 RMT & ACCEPT
POS II
RING SEAM #3
(1) THIRTY GRINDOUTS REWORKED BY CUTTING OUT 1 1/2 BEYOND SEAM TOWARD S1 & PUTTING IN NEW SEGMENT
(2) SEVEN GRINDOUTS IN NEW SEGMENT WELD ARE ACCEPTABLE
RING SEAM #1
(1) TEN GRINDOUTS (.040 MAX DEPTH) ACCEPT THREE GRINDOUTS (.360, .250 & .400 DEPTHS) REWELDED & ACCEPT
(2) ACCEPT
(5) BLEND .083 RMT & ACCEPT
POS I
(3) STRIP, DYE CHECK (NO DEFECTS) & ALODINE TOUCHUP & ACCEPT
(4) SAND & ACCEPT

REWORKS

VIEW LOOKING AFT

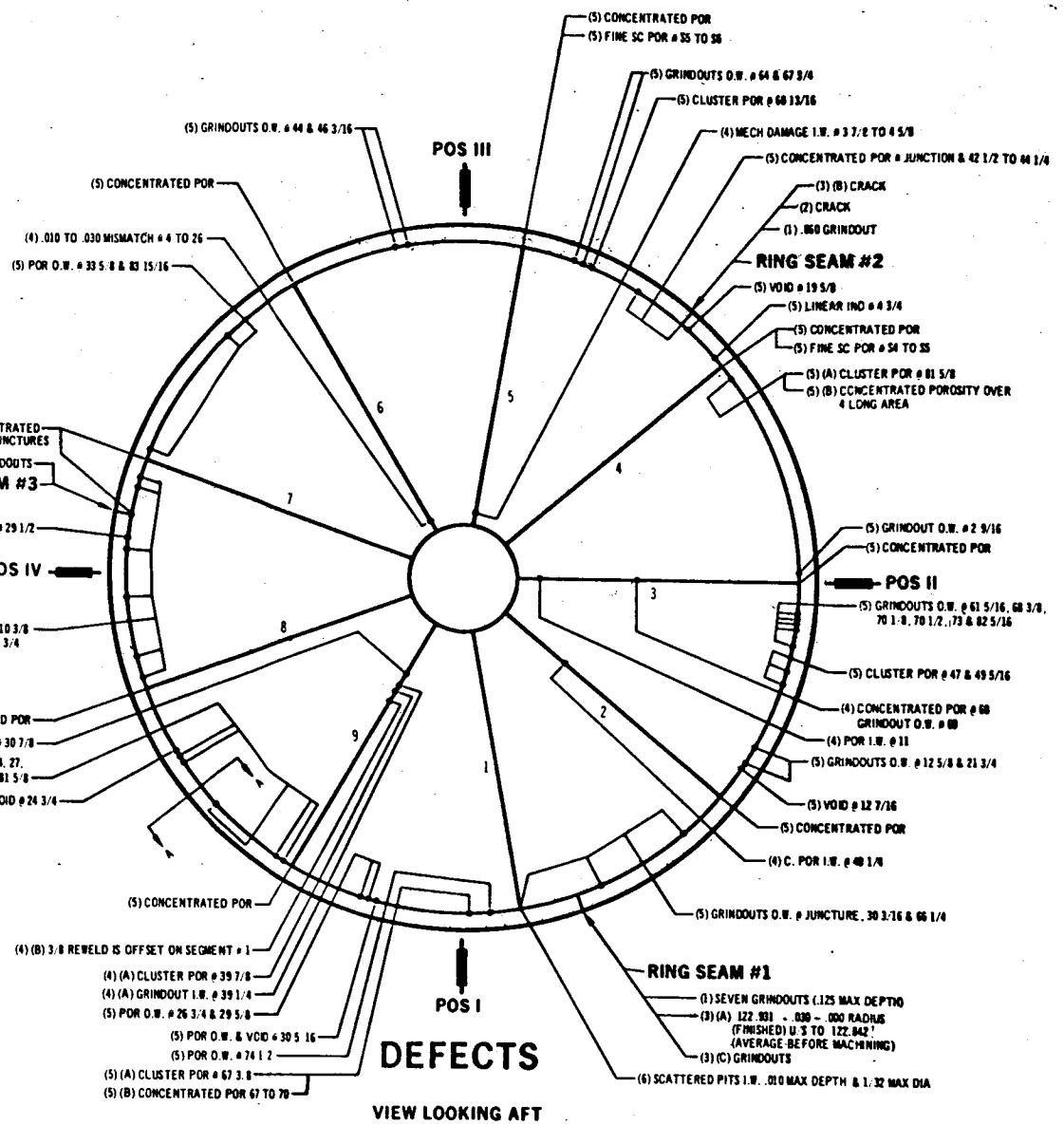


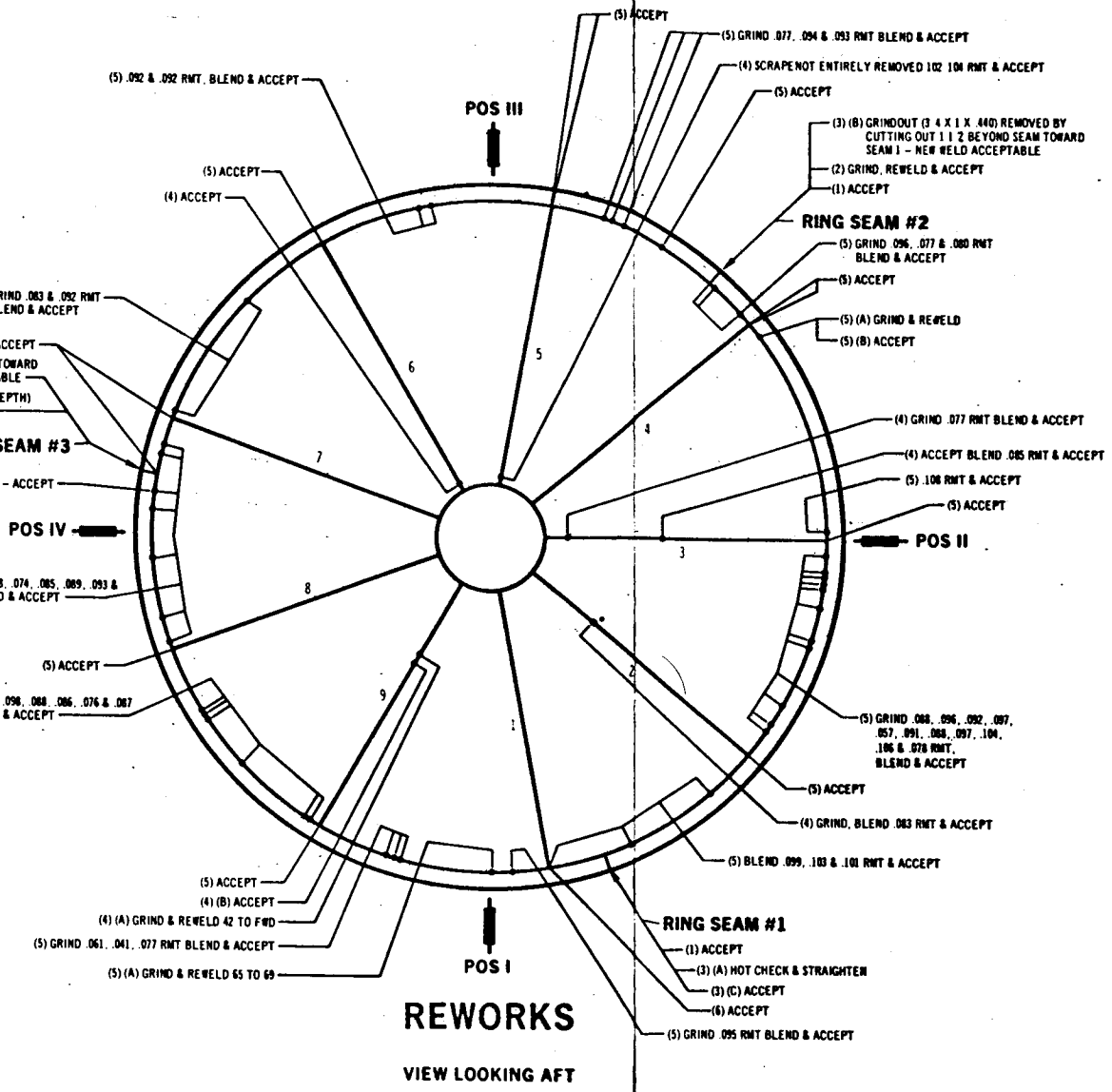


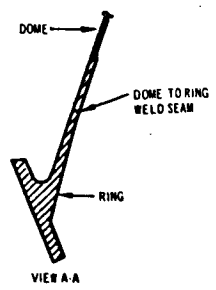
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	HOW REWORKED	REWELDS
1	A195593 BEFORE MACH	6-20-66	57	15	MANUAL MIG	1
21	A206740, BEFORE MACH	7-11-66	14	14	N/A	0
3	A206784	7-1-66	2	2	N/A	0
4	A206791	7-6-66	1	1	N/A	0
5	A206739 MER	7-11-66	18	18	N/A	0
6	A206861	7-21-66	3	3	N/A	0
7	A206875	8-3-66	1	1	N/A	0

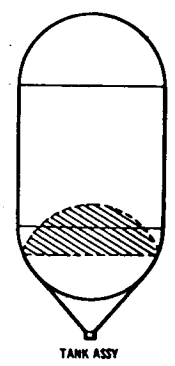
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS

Chart 4. Forward Face Assembly


(5) CONCENTRATED POR
(5) FINE SC POR ø 35 TO 36
(5) GRINDOUTS O.W. ø 64 & 67 3/4
(5) CLUSTER POR ø 68 13/16
(4) MECH DAMAGE I.W. ø 3 7/8 TO 4 5/8
(5) CONCENTRATED POR @ JUNCTION & 42 1/2 TO 44 1/4
(3) (B) CRACK
(2) CRACK
(1) .060 GRINDOUT
RING SEAM #2
(5) VOID ø 19 5/8
(5) LINEAR IND ø 4 3/4
(5) CONCENTRATED POR
(5) FINE SC POR ø 54 TO 55
(5) (A) CLUSTER POR ø 81 5/8
(5) (B) CONCENTRATED POROSITY OVER 4 LONG AREA
(5) GRINDOUTS O.W. ø 44 & 46 3/16
POS III
(5) CONCENTRATED POR
(4) .010 TO .030 MISMATCH ø 4 TO 26
(5) POR O.W. ø 33 5/8 & 83 15/16
(5) CONCENTRATED POR @ JUNCTURES
(1) CRACK, POR & GRINDOUTS
RING SEAM #3
(5) POR O.W. & VOID ø 29 1/2
POS IV
(5) POR O.W. ø 9 3 4, 10 3/8 32, 50 1 2, 73 & 82 3/4
(5) CONCENTRATED POR
(4) (A) C. POR O.W. ø 30 7/8
(5) POR O.W. ø 26 3 4, 27, 49 1 4, 79 5 8, & 81 5/8
(5) POR O.W. & VOID ø 24 3/4
(5) CONCENTRATED POR
(4) (B) 3/8 REWELD IS OFFSET ON SEGMENT # 1
(4) (A) CLUSTER POR ø 39 7/8
(4) (A) GRINDOUT I.W. ø 39 1/4
(5) POR O.W. ø 26 3/4 & 29 5/8
(5) POR O.W. & VOID ø 30 5 16
(5) POR O.W. ø 74 1 2
(5) (A) CLUSTER POR ø 67 3.8
(5) (B) CONCENTRATED POR 67 TO 70
POS I
DEFECTS
VIEW LOOKING AFT
(5) GRINDOUT O.W. ø 2 9/16
(5) CONCENTRATED POR
POS II
(5) GRINDOUTS O.W. ø 61 5/16, 68 3/8, 70 1-8, 70 1/2, 73 & 82 5/16
(5) CLUSTER POR ø 47 & 49 5/16
(4) CONCENTRATED POR ø 68 GRINDOUT O.W. ø 69
(4) POR I.W. ø 11
(5) GRINDOUTS O.W. ø 12 5/8 & 21 3/4
(5) VOID ø 12 7/16
(5) CONCENTRATED POR
(4) C. POR I.W. ø 40 1/4
(5) GRINDOUTS O.W. ø JUNCTURE, 30 3/16 & 66 1/4
RING SEAM #1
(1) SEVEN GRINDOUTS (.125 MAX DEPTH)
(3) (A) 122.933 - .030 - .000 RADIUS (FINISHED) 8 5 TO 122.942" (AVERAGE-BEFORE MACHINING)
(3) (C) GRINDOUTS
(6) SCATTERED PITS I.W. .010 MAX DEPTH & 1.32 MAX DIA


(5) ACCEPT
(5) GRIND .077, .094 & .093 RMT BLEND & ACCEPT
(4) SCRAPE NOT ENTIRELY REMOVED 102 104 RMT & ACCEPT
(5) ACCEPT
(3) (B) GRINDOUT (3 4 X 1 X .440) REMOVED BY CUTTING OUT 1 1 2 BEYOND SEAM TOWARD SEAM 1 – NEW WELD ACCEPTABLE
(2) GRIND, REWELD & ACCEPT
(1) ACCEPT
RING SEAM #2
(5) GRIND .096, .077 & .080 RMT BLEND & ACCEPT
(5) ACCEPT
(5) (A) GRIND & REWELD
(5) (B) ACCEPT
(4) GRIND .077 RMT BLEND & ACCEPT
(4) ACCEPT BLEND .085 RMT & ACCEPT
(5) .108 RMT & ACCEPT
(5) ACCEPT
POS II
(5) GRIND .088, .096, .092, .097, .057, .091, .088, .097, .104, .106 & .078 RMT, BLEND & ACCEPT
(5) ACCEPT
(4) GRIND, BLEND .083 RMT & ACCEPT
(5) BLEND .099, .103 & .101 RMT & ACCEPT
RING SEAM #1
(1) ACCEPT
(3) (A) HOT CHECK & STRAIGHTEN
(3) (C) ACCEPT
(6) ACCEPT
(5) GRIND .095 RMT BLEND & ACCEPT
(5) ACCEPT
(4) (B) ACCEPT
(4) (A) GRIND & REWELD 42 TO FWD
(5) GRIND .061, .041, .077 RMT BLEND & ACCEPT
(5) (A) GRIND & REWELD 65 TO 69
POS I
REWORKS
VIEW LOOKING AFT
(5) .092 & .092 RMT, BLEND & ACCEPT
(5) ACCEPT
(4) ACCEPT
(5) GRIND .083 & .092 RMT BLEND & ACCEPT
(5) ACCEPT
(3) (B) CUTOUT 1 1/2 BEYOND SEAM TOWARD SEAM 1 – NEW WELD ACCEPTABLE
(1) GRIND, FIVE PLACES (.065 MAX DEPTH) & ACCEPT
RING SEAM #3
(5) VOID – ACCEPT
POS IV
(5) GRIND .097, .078, .074, .085, .089, .093 & .087 RMT BLEND & ACCEPT
(5) ACCEPT
(5) GRIND .060, .096, .088, .086, .076 & .087 RMT BLEND & ACCEPT

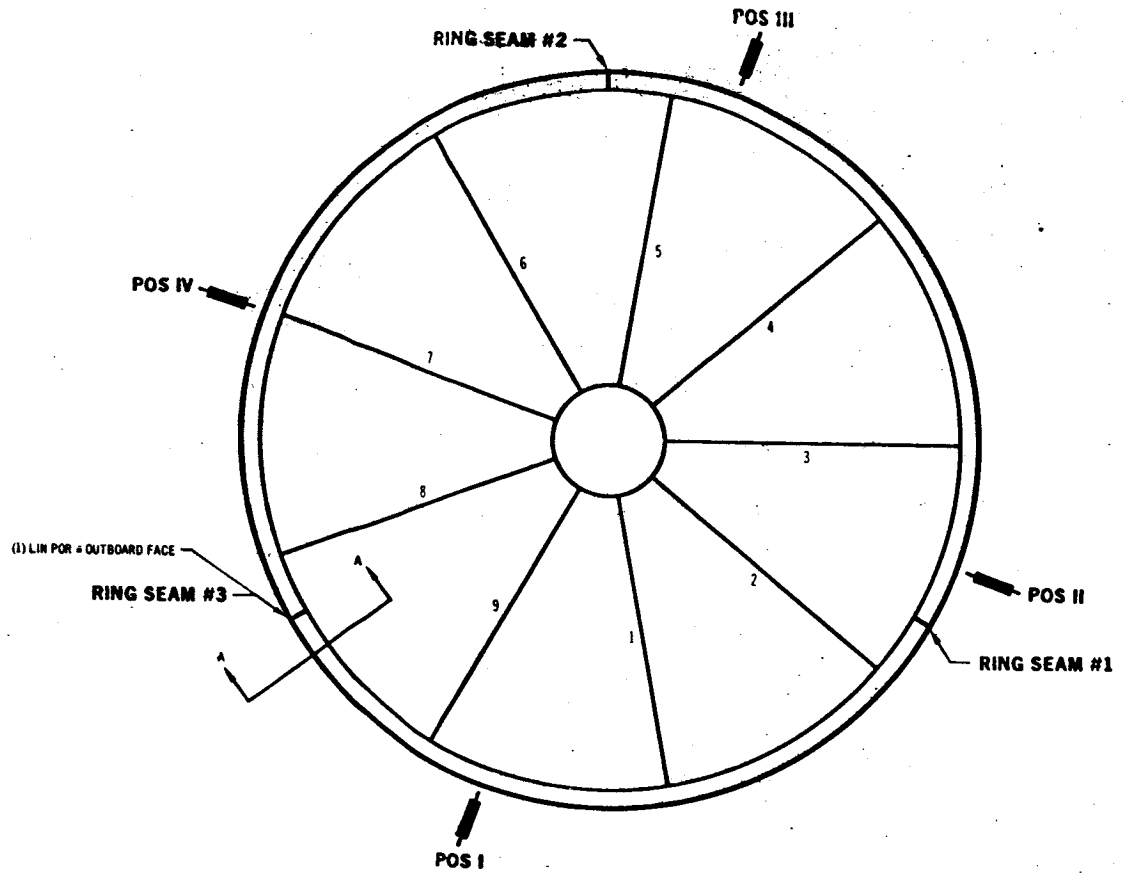




ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	HOW REWORKED	REWELDS
1	A195579 BEFORE MACH	6-3-66	13	13	N/A	0
2	A195581, AFTER CHECK & STR	6-7-66	1	1	MANUAL MIG	1
3	A206774 BEFORE MACH	6-27-66	3	2	N/A	0
4	A206781 MER	6-29-66	10	5	AUTO MIG	1
5	A206830 RING	8-9-66	57	44	AUTO MIG	2
6	A206885	8-14-66	1	0	N/A	0

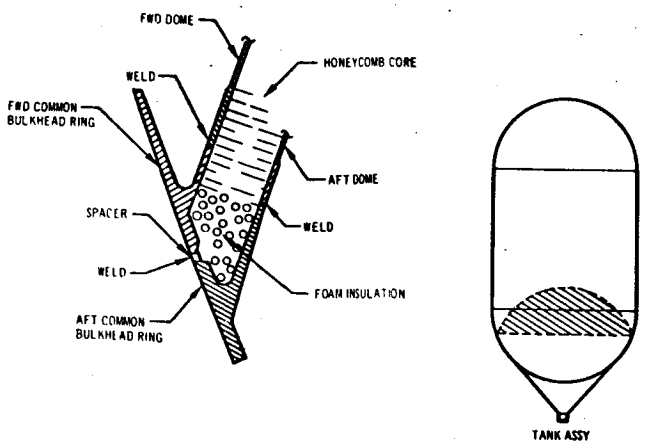
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS

Chart 5. Aft Face Assembly

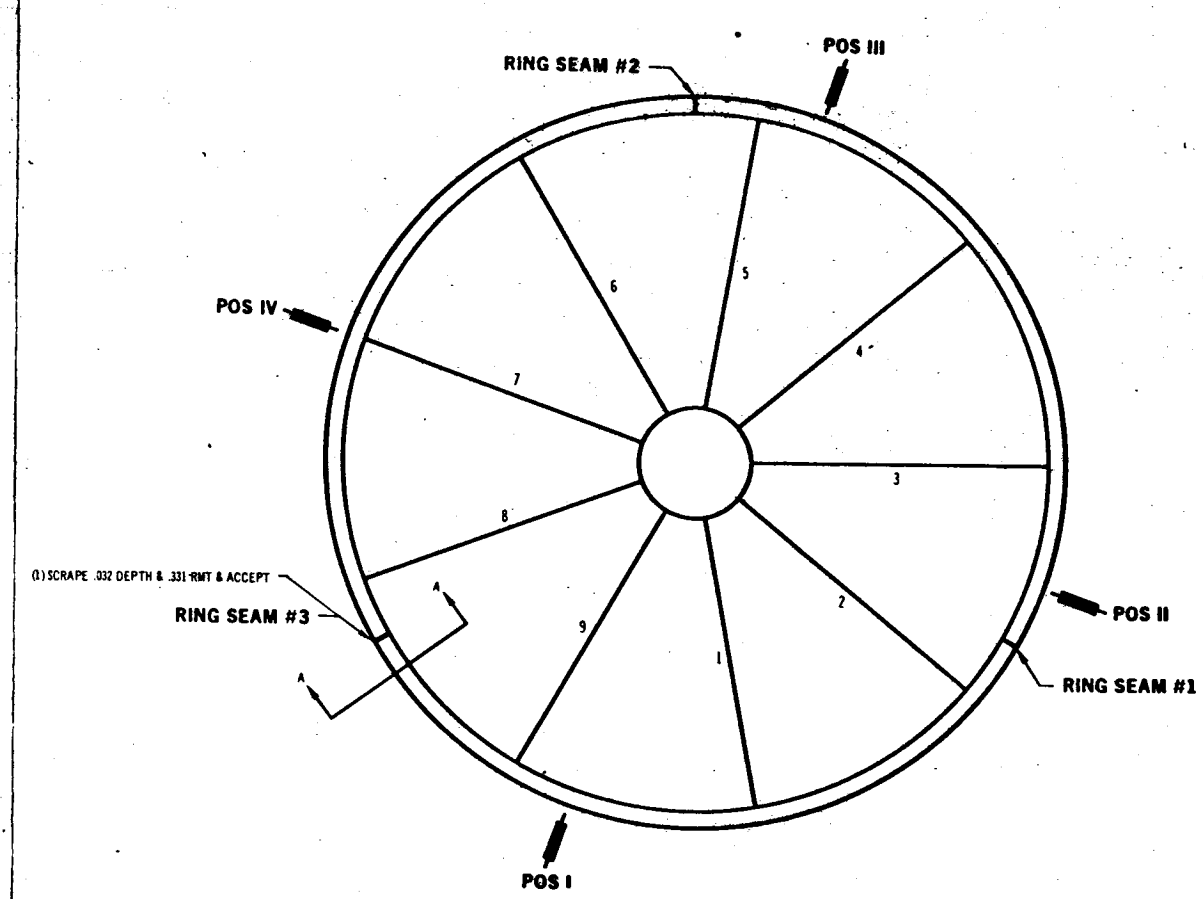


DEFECTS

VIEW LOOKING AFT



ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	HOW REWORKED	REWELDS
1	A220521	9-2-66	1	1	N A	0



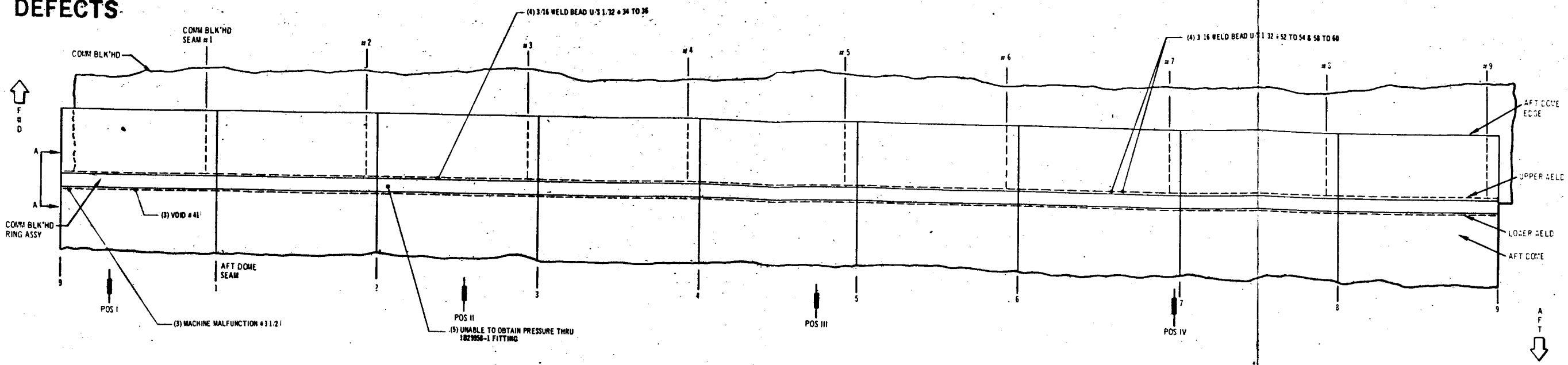
REWORKS

VIEW LOOKING AFT

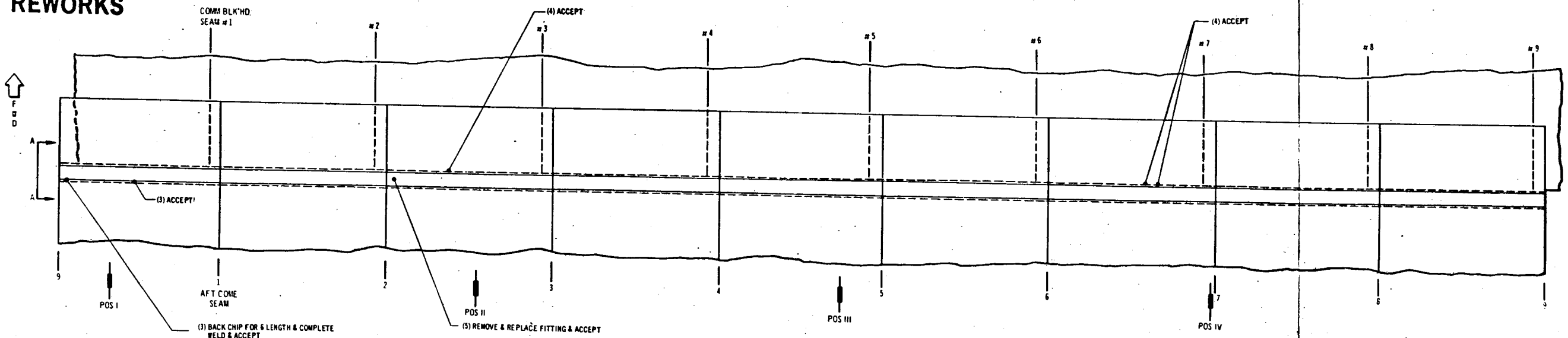
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS

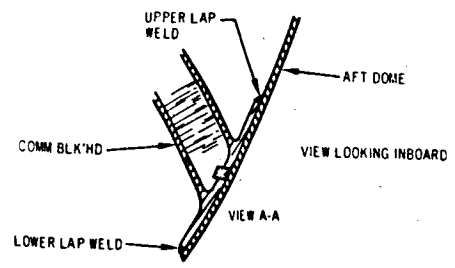
Chart 6. Common Bulkhead Assembly

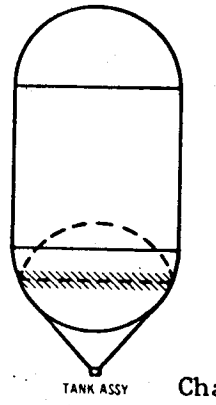
DEFECTS



REWORKS





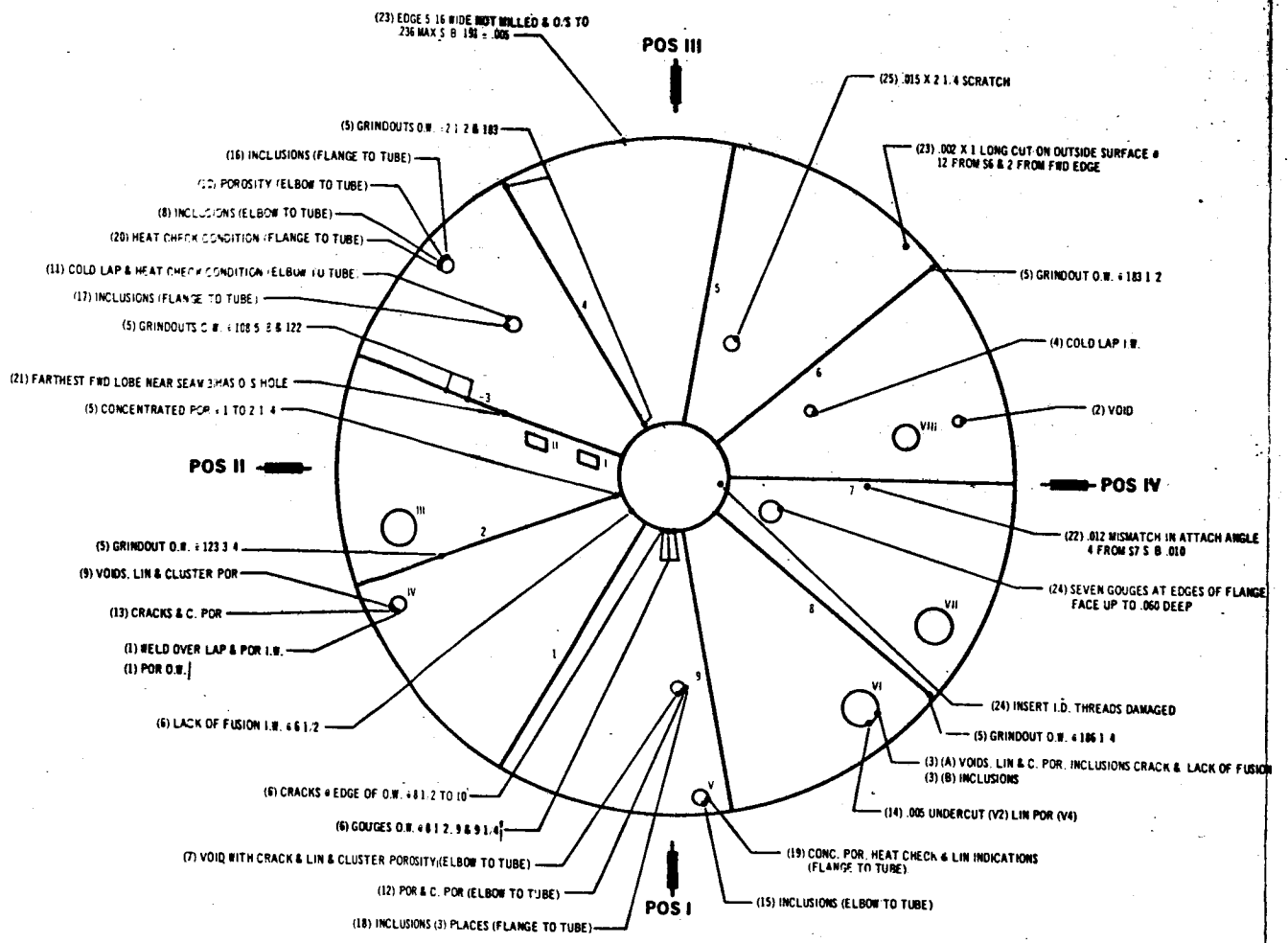


LEGEND

ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS
1	A206848	8-21-66	SEE	AFT DOME -	ITEM 21	
2	A206899	8-23-66	SEE	AFT DOME	ITEM 22	
3	A220568	9-7-66	2	1	AUTO MIG	1
4	A220571	9-8-66	3	0	N A	0
5	A220487	10-18-66	1	1	N/A	0

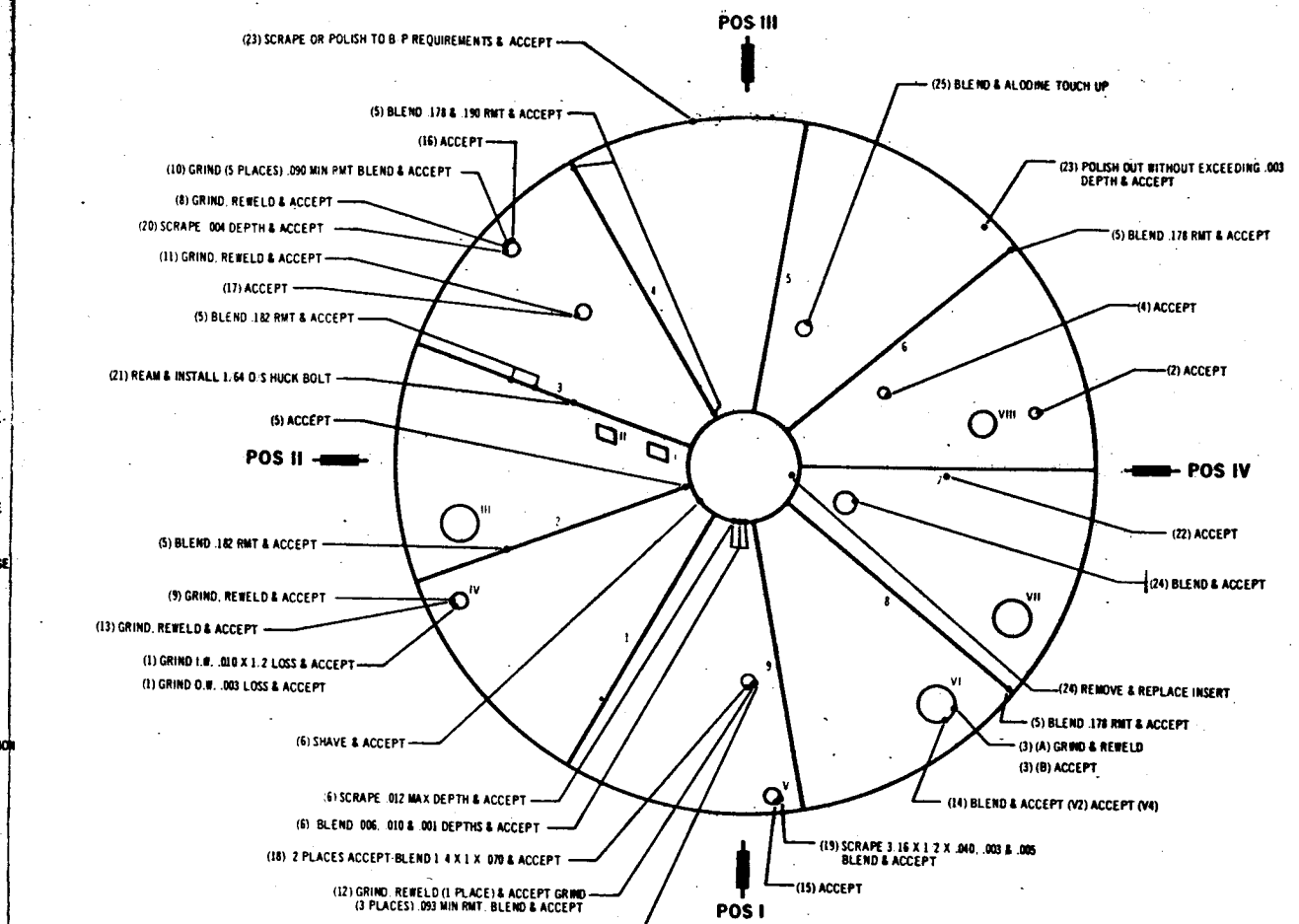
ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS

Chart 7. Common Bulkhead to Aft Dome Welds


POS III
POS II
POS IV
POS I
(23) EDGE 5.16 WIDE NOT MILLED & O.S TO 236 MAX S B 191 ± .005
(5) GRINDOUTS O.W. 2 1 2 & 183
(16) INCLUSIONS (FLANGE TO TUBE)
(12) POROSITY (ELBOW TO TUBE)
(8) INCLUSIONS (ELBOW TO TUBE)
(20) HEAT CHECK CONDITION (FLANGE TO TUBE)
(11) COLD LAP & HEAT CHECK CONDITION (ELBOW TO TUBE
(17) INCLUSIONS (FLANGE TO TUBE)
(5) GRINDOUTS O.W. 108 S B & 122
(21) FARTHEST FWD LOBE NEAR SEAM 3 MAS O S HOLE
(5) CONCENTRATED POR 1 TO 2 1 4
(5) GRINDOUT O.W. 123 4
(9) VOIDS, LIN & CLUSTER POR
(13) CRACKS & C. POR
(1) WELD OVER LAP & POR I.W.
(1) POR O.W.
(6) LACK OF FUSION I.W. 6 6 1.2
(6) CRACKS @ EDGE OF O.W. 6 8 1.2 TO 10
(6) GOUGES O.W. 6 8 1.2, 9 & 9 1.4
(7) VOID WITH CRACK & LIN & CLUSTER POROSITY (ELBOW TO TUBE)
(12) POR & C. POR (ELBOW TO TUBE)
(18) INCLUSIONS (3) PLACES (FLANGE TO TUBE)
(25) .015 X 2 1.4 SCRATCH
(23) .002 X 1 LONG CUT ON OUTSIDE SURFACE @ 12 FROM S6 & 2 FROM FWD EDGE
(5) GRINDOUT O.W. 183 1 2
(4) COLD LAP I.W.
(2) VOID
(22) .012 MISMATCH IN ATTACH ANGLE @ FROM S7 S B .010
(24) SEVEN GOUGES AT EDGES OF FLANGE FACE UP TO .060 DEEP
(24) INSERT I.D. THREADS DAMAGED
(5) GRINDOUT O.W. 106 1 4
(3) (A) VOIDS, LIN & C. POR, INCLUSIONS CRACK & LACK OF FUSION
(3) (B) INCLUSIONS
(14) .005 UNDERCUT (V2) LIN POR (V4)
(19) CONC. POR, HEAT CHECK & LIN INDICATIONS (FLANGE TO TUBE)
(15) INCLUSIONS (ELBOW TO TUBE)

DEFECTS

VIEW LOOKING FWD

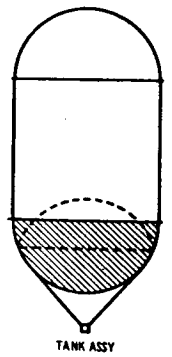

POS III
POS II
POS IV
POS I
(23) SCRAPE OR POLISH TO B P REQUIREMENTS & ACCEPT
(5) BLEND .178 & .190 RMT & ACCEPT
(16) ACCEPT
(10) GRIND (5 PLACES) .090 MIN PMT BLEND & ACCEPT
(8) GRIND, REWELD & ACCEPT
(20) SCRAPE .004 DEPTH & ACCEPT
(11) GRIND, REWELD & ACCEPT
(17) ACCEPT
(5) BLEND .182 RMT & ACCEPT
(21) REAM & INSTALL 1.64 O.S HUCK BOLT
(5) ACCEPT
(5) BLEND .182 RMT & ACCEPT
(9) GRIND, REWELD & ACCEPT
(13) GRIND, REWELD & ACCEPT
(1) GRIND I.W. .010 X 1.2 LOSS & ACCEPT
(1) GRIND O.W. .003 LOSS & ACCEPT
(6) SHAVE & ACCEPT
(6) SCRAPE .012 MAX DEPTH & ACCEPT
(6) BLEND .006, .010 & .001 DEPTHS & ACCEPT
(18) 2 PLACES ACCEPT-BLEND 1 4 X 1 X .070 & ACCEPT
(12) GRIND, REWELD (1 PLACE) & ACCEPT GRIND (3 PLACES) .093 MIN RMT, BLEND & ACCEPT
(7) GRIND, REWELD & ACCEPT
(25) BLEND & ALODINE TOUCH UP
(23) POLISH OUT WITHOUT EXCEEDING .003 DEPTH & ACCEPT
(5) BLEND .178 RMT & ACCEPT
(4) ACCEPT
(2) ACCEPT
(22) ACCEPT
(24) BLEND & ACCEPT
(24) REMOVE & REPLACE INSERT
(5) BLEND .178 RMT & ACCEPT
(3) (A) GRIND & REWELD
(3) (B) ACCEPT
(14) BLEND & ACCEPT (V2) ACCEPT (V4)
(19) SCRAPE 3.16 X 1 2 X .040, .003 & .005 BLEND & ACCEPT
(15) ACCEPT

REWORKS

VIEW LOOKING FWD

LEGEND

I BRACKET
II BRACKET
III FITTING ASSY (LOX FILL LINE)
IV ELBOW ASSY (LH_2 FILL LINE)
V ELBOW ASSY (LH_2 CHILL RETURN)
VI FITTING ASSY (LH_2 FEED LINE)
VII FLANGE (LH_2 CHILL PUMP)
VIII FLANGE (LOX VENT)
IX SENSOR
X LOX INSTR PROBE
XI LOX CHILL RETURN
XII LH_2 HELIUM HEATER
XIII LOX HELIUM HEATER
XIV LOX CHILL PUMP
XV P.U. PROBE



TANK ASSY

* HAND WELD

ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	HOW REWORKED	REWELDS
1	A206743 F-F	7-13-66	3	3	N A	0
2	A206802 AL	7-21-66	1	0	N A	0
3	A206805 G-G	7-23-66	14	1	AUTO TIG	1
4	A206807 L-L	7-23-66	1	0	N A	0
5	A206809 MER	7-27-66	8	7	N A	0
6	A206873 FL	7-31-66	5	5	N A	0
7	A206818 * AR	8-5-66	3	1	MANUAL TIG	1
8	A206819 * AU	8-5-66	2	1	MANUAL TIG	1
9	A206820 * FF	8-5-66	2	1	MANUAL TIG	1
10	A206823 * AU	8-8-66	5	5	N A	0
11	A206824 * AT	8-8-66	2	1	MANUAL TIG	1
12	A206825 * AR	8-8-66	4	1	MANUAL TIG	1
13	A206826 * F-F	8-8-66	11	1	MANUAL TIG	1
14	A206834 * G-G	8-15-66	2	1	N A	0

ITEM	FARR NUMBER	INITIATION DATE	DEFECTS	REWORKS REQUIRED	WELDING REWORK	REWELDS
15	A206835 * AP	8-15-66	1	0	N/A	0
16	A206837 * AU	8-16-66	1	0	N/A	0
17	A206838 * AT	8-16-66	3	0	N/A	0
18	A206839 * AR	8-16-66	3	1	N/A	0
19	A206840 * AP	8-16-66	3	3	N/A	0
20	A206842 * AU	8-16-66	1	1	N/A	0
21	A206848	8-21-66	1	1	N/A	0
22	A206899	8-23-66	1	0	N/A	0
23	A217190	9-16-66	2	2	N/A	0
24	A217200	10-3-66	2	2	N/A	0
25	A220481	10-6-66	1	1	N/A	0

Chart 8. Aft Dome Assembly

APPENDIX II

CHARTS

APPENDIX III

TABLES

TABLE I. FAILURE AND REJECTION REPORTS OF
PERMANENT NONCONFORMANCES, STRUCTURAL ASSEMBLIES

Section 1. Propellant Tank Assembly, P/N 1A39303-521

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A217135 10-28-66	As noted on FARR A217136, the strap support clip assemblies, for attachment of auxiliary tunnel cover were misaligned 5/32 in. The maximum allowable misalignment per B/P 1B27716 was 1/32 in.	Clips were removed and reinstalled per B/P. The rework was acceptable.
A217136 10-27-66	Three strap assemblies, P/N 1B27716-401, were rebonded to the auxiliary tunnel exterior, without Engineering authorization.	The adhesive bonding the straps to the tunnels was allowed to dry at room temperature. After the drying was effected, the straps were found to have been misaligned. This problem, along with its solution, was recapped to FARR A217135.
A217139 11-10-66	The installation of clip, P/N 1B37888-529, failed to meet minimum requirements of DPS 32330. Scrim cloth did not extend to bond line of clip. It should have had a minimum overlap of 1/4 in.	Acceptable to Engineering for use.
A217140 11-10-66	The installation of five clips, P/N 1B27099-5D, failed to meet minimum requirements of DPS 32330 H. Scrim cloth did not extend to bond line of clip. It should have overlapped the bond line by at least 1/4 in.	Acceptable to Engineering for use.
A217141 11-10-66	The installation of clip, P/N 1B37888-529, failed to meet minimum requirements of DPS 32330 for a 1/4 in. scrim cloth overlap. Scrim cloth did not extend to bondline of clip.	Acceptable to Engineering for use.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A217142 11-14-66	Adhesive and Scrim cloth were removed from bond line of strap assembly, P/N 1A39313-401, in main tunnel exterior, 8 in. from aft attach angle. Scrim cloth should have extended at least 1/4 in. beyond the periphery of the strap assembly.	Acceptable to Engineering for use.
A217145 11-6-66	A Scrim cloth extended 1/16 in. beyond surface of clip, P/N 1B37888-533. DPS 32300 "H" minimum was 1/4 in.	Acceptable to Engineering for use.
A217146 11-20-66	Support, P/N 1B27099-3, located on the aft dome exterior, aft of the thrust structure attach angle, and counter-clockwise of the center line of the LOX fill outlet, was cracked.	The support was removed and replaced per B/P. The rework was acceptable.
A217147 11-21-66	Adhesive bonds of exterior supports, P/N's 1B37888-529, 1B50529-1, 1B37414-1, 1B37888-537, 1B27716-409, 1B27716-410, 1B27716-401.1, and 1B37147-405.1, to the tank assembly did not comply with DPS 32330 strength test requirements of 27 in. lb/in. average, 18 in. lb/in. min.	The supports were removed per DPS 32330 and rebonded per B/P.
A217150 11-27-66	One finger of support, P/N 1B37763-1, was debonded from the outside surface of the aft dome, P/N 1A39308-513, 8.25 in. clockwise from the LOX vent port. The debonded area measured 3/8 in. deep x 7/8 in. in length.	Adhesive was injected into the unbonded area per Engineering instructions, and was allowed to cure for 24 hours. After review of tensile test results, the rebonding was accepted for use.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A217178 8-25-66	Weld beads were not shaved after support installation per B/P's 1B37738N and 1B27099M. The maximum allowable protrusion of the weld bead above the parent material was 0.005 in.	Weld was shaved to B/P tolerance, and was acceptable to insepction.
A217194 9-21-66	Dye check of the outside aft dome to cylinder weld revealed a greater than No. 3 porosity on the aft face of the ring at the No. 2 butt weld, 69 3/8 in. from seam 4 toward seam 5.	After machining, dye penetrant inspection revealed a 1/4 in. linear indication at the same location. This indication was ground out, blended, polished, etched, dye checked, and accepted.
A217195 9-21-66	Door jamb doubler installation on forward dome of propellant tank assembly, P/N 1A39303-521, S/N 1009, showed the following: a. Thin films of adhesive under lockbolt heads and collars. b. Voids, unbonded areas, extending into bondline to a depth of 3/16 in. c. Numerous splatter spots where anodize was removed.	a and b. Acceptable to Engineering for use. c. Contaminants were removed as required with damp cloth dipped in distilled water, by lightly sanding with No. 400 carborundum paper. Rework was acceptable to Engineering for use.
A217196 9-26-66	X-ray of the inside forward dome to cylinder weld revealed irregular lines emerging from the setup line at angles ranging from 45° to 90°. The lines were at 23 locations.	The defect areas were rewelded, and X-ray revealed a 0.080 void between seams 4 and 5. The weld was ground, blended and chipped. A post-production sample was prepared, X-rayed, dye checked, and tensile tested. Following this rework, the weld was accepted for use.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A217197 9-30-66	a. Between cleaning and welding operations of forward dome to cylinder outside weld area, the seven days allowed per DPS 14052-5, were exceeded. b. Preproduction sample exceeded 14 days allowed between the preproduction and start of the production weld per DPS 1452.	a. Acceptable to Engineering for use. b. A post-production sample was prepared, and successfully passed dye, X-ray, and tensile strength tests.
A217198 10-1-66	After first pass of multiple pass outside weld of the forward dome to cylinder weld, numerous holes in center of weld from 0.025 to 0.125 in. in diameter were noted as follows: a. Seam 1 toward seam 2, at 75 to 77 in. and at 86 to 88 1/4 in. b. Seam 3 toward seam 4 at 44 to 44 1/2 in. c. Seam 9 toward seam 1 at 38 to 39 in. and 54 to 59 in.	Entire periphery of fillet weld of forward attachment ring to forward dome was X-rayed. Defects were removed by chipping and grinding; area was rewelded to one-pass level. Second resubmit disposition incomplete; further disposition is noted in FARR A217477.
A217200 10-3-66	At the aft dome, segment 8, inspection showed the following defects: a. 1. Four gouges with a maximum depth of 0.060 in. 2. Three gouges with a maximum depth of 0.050 in. b. Internal threads were damaged in DAC-2 LOX jamb insert.	a. The gouged areas were blended to remove protruding metal and obtain a 63 finish without extending damage areas. Rework was acceptable. b. The damaged insert was removed and replaced.
A220451 11-2-66	On aft dome and aft end of propellant tank assembly, P/N 1A39303-521, S/N 1009, a stud was broken during torque test, 16 in. to the right of weld seam 8. Spot face was 0.055 in. deep.	Spot face depth was increased to 0.060 in. maximum to remove pitting condition. New stud was installed. Rework was accepted.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220453 11-20-66	a. Vacuum was removed, without authorization, from forward cylinder seam door ring and aft dome seam 5 of tank assembly, P/N 1A39303-521, S/N 1009, before acceptance of coupon test results to DPS 23003. b. Requirements of DPS 23003 were not complied with on the aft dome seam 5 installation. One test coupon had a minimum strength of 78 psi, which was below the acceptable minimum of 100 psi.	Acceptable to Engineering for use.
A220454 11-21-66	Liner to dome adhesive tensile test specimens representing forward dome, P/N 1A39304, segments 6 and 7, failed to meet the requirements of DPS 23003. Specimen, S/N 18, representing segment 6, had an average tensile strength of 112 psi, which was below the allowable minimum of 150 psi. Specimen, S/N 19, representing segment 7, failed both the minimum average and minimum single run criteria, with 113 and 66 psi respectively.	Acceptable to Engineering for use.
A220459 12-6-66	Glass liner on tank assembly, P/N 1A39303-521, S/N 1009, failed to meet strength requirements average of 150 psi or more, and no value below 100 psi, DPS 23003, para. 8.4.5. a. Glass liner on stop-off seams 1 through 5 on forward dome showed average of 149 psi. b. Glass liner on stop-off seams 1 through 9 on aft dome showed average of 139 psi.	Acceptable to Engineering for use.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220476 10-3-66	A gap check of tank assembly chill bars, P/N 1A39303-1SF7, showed gaps at the forward side, from 0.005 to 0.011 in., at depths of 3/4 in. around circumference. Per DPS 14052-5, gaps should not exceed 3/8 in.	Acceptable to Engineering for use.
A220477 10-4-66	After second pass outside weld of forward dome to cylinder, P/N 1A39303-521, S/N 1009, cratered holes were noted in center of weld bead to 0.125 in. in diameter; gap at chill bars after resubmit 2 is as follows: a. Seam 9 toward seam 1, 37 1/2 - 39 in., 4 places and 54 - 56 in., three places. b. Seam 8 towards seam 9, at 52 in., one place; void at surface of grindout, 54 3/8 in. c. Seam 7 towards seam 8, at 72 in., one place; void at surface of weld, 51 5/8 in.	X-ray, dye check, tensile test, and visual inspection of fourth resubmit of post-production weld, acceptable to Engineering for use.
A220481 10-6-66	The outside surface of the PU probe outlet flange, P/N 1A39152-501, had surface cuts, 0.015 in. maximum in depth and 2 1/4 in. long, parallel to conoseal surface of aft dome segment 6.	Area was blended out to eliminate protruding metal and sharp edges, and to achieve required surface finish. Area was alodined per DPS 41410. The rework was acceptable.
A220482 10-6-66	Visual inspection of the forward dome to cylinder attach angle weld of tank assembly, P/N 1A39303-521, S/N 1009, revealed that after third pass, there was underfill adjacent to dome, varying in depth from 1/32 to 3/32 in., and in area to 1/8 in.	Following milling per B/P requirements the condition was acceptable to Engineering for use.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220485 10-12-66	Vehicle adhered to forward lower half of roller ring, P/N A652-1A39303-1HF2, and did not release when hoisted. Although no visible damage to the tank existed following the toluene application, the jig ring rubber pad still adhered to the tank.	Rubber to rubber area was saturated with toluene cleaner. A torque depressor was used to enable the Toluene to flow onto the rubber surface of the tank. The portions of the rubber pad remaining on the roll jig were removed by plastic scraper and toluene solvents. Rework was acceptable to Engineering for use.
A220487 10-18-66	A LOX dome position II weld seam connecting the control panel, P/N A659-1A57431-PTE3 to the common dome failed to obtain pressure through tap fitting P/N 1B29958-1.	Tap fitting P/N 1B29958-1 was removed and replaced and the test continued per DPS 40014 requirements.
A220500 12-6-66	Inside the LH_2 tank, P/N 1A49306-511, starting at the forward end of bank 1, there were cuts in the inboard conoseal surface on helium ports 1, 2, and 3. The cuts had maximum length of 1/16 in., and depth of 0.003 in.	The burred edges of the scratches were removed; care was taken not to mar the finish of the conoseal surface. The helium bottles were installed and leak checked per B/P. The results were acceptable.
A233554 12-14-66	Deficiencies inside the LH_2 tank, P/N 1A39306-511, S/N 1009, were noted as follows: a. At segment 4, adjacent to seam 3, baffle attached to stud, P/N 1B55693-1, was broken. b. At segment 7, adjacent to seam 7, stud, P/N 1B55899-1 should have been P/N 1B55898-1.	Studs were removed and replaced as required per B/P 1B55745NC. Glass liner was reinstalled per DPS 23003. The rework was acceptable.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A233556 12-17-66	a. Rope, P/N 1B56518-9, was stitched on the aft side of deflector assembly, P/N 1B56516-1. It should have been installed on the forward side. The mislocation was necessary due to the improper installation of the deflector assembly, which had been rotated 180° out of B/P location.	Acceptable to Engineering for use.
A233557 12-19-66	Glass liner inside LH_2 tank assembly, P/N 1A39306-511, S/N 1009, was damaged as follows: a. A 1 in. tear through the liner of cylinder segment 5, tile 297. b. A 1/4 in. cut through the liner of forward dome segment 5. c. A 3/8 in. long cut through the liner of cylinder segment 1, tile 192.	Areas reworked per DPS 23003, method I. Rework was acceptable.
A233574 1-13-67	Stud, P/N S0717A428-5, was noted next to the LOX tank SVE instrumentation probe wire leadout port.	Acceptable to Engineering for use.

TABLE I (Continued)

Section 2. Forward Dome, P/N 1A39304-515

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206810 7-29-66	X-ray 66-B89 of forward dome segment 8, P/N 1A39304-467, S/N 1008A, showed a disturbed setup line V1 and V2 in the AE-AE clip.	Acceptable to Engineering for use without rework.
A206831 8-9-66	X-ray, dye check and visual inspection of the forward dome meridian welds, P/N 1A39304-463, S/N 1008A, showed: a 0.016 in. grindout in meridian weld seam 2, at 1 1/8 in.; seam 3, clusters of porosity at 22 7/16 and 22 13/16 in., grindouts at 11 1/2, 40 1/16, 43, 137 1/4, 150 1/4, 167 5/8, and 139 3/8 in.; seam 4, grindouts at 9 and 46 7/8 in.; and seam 9, concentrated porosity at 32 5/16 in and 32 7/8 in. and grindouts at 7 15/16, 8 5/16, 32 5/8, and 103 3/16 in.	The defective areas were reworked by grinding, etching, smoothing, blending, dye checking and rewelding where necessary. The rework was acceptable to Engineering for use.
A206844 8-17-66	X-ray, dye penetrant, and visual inspection of the forward dome door flange installation, P/N 1A39304-461, S/N 1008A, seam 5 to seam 6, showed cluster of porosity at 1 1/4 in.	Acceptable to Engineering for use without rework.
A206883 8-12-66	Scrape marks to a depth of 0.003 in. in meridian weld and segments on outer side of forward dome, P/N 1A39304-463, S/N 1008A, at flush areas of seams 2, 8, and 9. On outer side of seam 3, scattered pits in weld to a depth of 0.005 in. and a diameter of 1/64 in. Depressions in outer flush weld of seam 7: 1, 1 5/8, and 3 in. from forward trimline, 0.003, 0.003, and 0.05 in. deep respectively.	Acceptable to Engineering for use.

TABLE I, Section 2 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206884 8-12-66	a. Periphery of forward dome, P/N 1A39304-463, S/N 1008A, was trimmed 0.125 in. beyond that called out in the AO. b. Spherical contours and fitting locations check showed offset corrections were not provided.	a. Acceptable to Engineering for use. b. Contours and fittings were checked allowing 1/8 in. additional trim. After check, acceptable to Engineering for use.
A206892 8-18-66	A can condition caused by weld shrinkage in segment 3 of forward dome flange weld, P/N 1A39304-361, S/N 1008A, 7 X 9 X 0.104 in. It was noted that the can is smooth, with no sharp creases, and will not pop out.	Acceptable to Engineering for use without rework.
A206897 8-20-66	Bracket P/N 1B41942-1, welded to inside surface of section 18 of the forward dome, P/N 1A39304-495, S/N 1008A, was out of rotation 15° so that bracket 1B66145-1 would not fit into end of 1B41942-1.	Acceptable to Engineering for use.
A206898 8-22-66	On inside surface of segment 7 of the forward dome flange weld, P/N 1A39304-461, S/N 1008A, showed: a. Scratches in the thin area of the segment 9 in. from seam 7 and 90-92 in. from the flange weld, to a depth of 0.003 in. and a maximum length of 1 1/2 in. b. A scratch across weld pad of segment 7 at flange area inside surface, 4 1/4 in. from seam 6 toward seam 7, to a depth of 0.003 in.	Instructions given to break all sharp edges and smooth scratches. The rework was accepted.

TABLE I, Section 2 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220553 8-26-66	Following a contour check of the forward dome assembly, P/N A200553, S/N 1008A, out-of-tolerance at 82° latitude in seams 1 through 6, caused by weld shrinkage, were noted.	Acceptable to Engineering for use.

TABLE I (Continued)

Section 3. Cylindrical Tank Assembly, P/N 1A39306-511

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A195556 5-13-66	X-ray 66-B49 of the clevis to cylindrical tank installation, 4A, View 2 showed linear porosity.	Acceptable to Engineering for use.
A203622 7-27-66	Visual inspection of seam 4 butt weld revealed lack of penetration and underfill as follows: a. Underfill on inside at 182 1/2 in. from forward end of cylinder, 1/2 in. long at edge of segment in chamfer. b. Lack of penetration on drop through, 193 in. from forward end of cylinder, 1/4 in. long.	a and b. Both sides of weld were shaved in the area from 181 to 194 in. to B/P tolerance; remaining area flush. Seam X-rayed and resubmitted to inspection. Rework of groove rejected; refer to FARR A216981 for details.
A203625 7-28-66	Weld stoppage occurred during weld of long seam 5, 112 1/2 in. from forward end of cylindrical tank, P/N 1A39306-511, S/N 1009. X-ray 66-57 revealed a transverse crack across the end of the penetrated OD bead, 112 1/2 in. from forward end of tank at weld stop area, and a star crack on ID, opposite the transverse crack. These cracks remained after the weld was shaved and ground flush and a groove cut to conform to preproduction sample. a. Segment 6 was removed by trimming weld from adjoining edge of segment 5. b and c. The edge of segment 5 was rechamfered per drawing requirements and dye checked. d. A new segment 6 was prepared and the width increased to maintain overall dimensions.	A preproduction weld of the star crack per DPS 14052 was acceptable to Engineering for use following a dye check, X-ray, and tensile strength report. The preproduction test specimen was acceptable to Engineering for use. Seam 5 was welded per DPS 14052 and the procedures used on preproduction specimens, and the results were accepted.

TABLE I, Section 3 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A203625 (Cont.)	e. Preproduction samples were prepared simulating the trim after rework, rewelded, and tested per DPS 14052. f. Test results were resubmitted to inspection.	
A206733 7-5-66	Dye check of support fittings showed the following defects: 25 porosities; lack of fusion, two places; linear porosity, three places. Dye check after reweld showed crater cracks, connected porosity, lack of fusion (two places). Six welds were required. Linear porosities appeared and were blended out.	All fittings with No. 3 porosities were ground lightly to remove the defects. Grindouts of 0.100 in. or more were mechanically rewelded after chipping out the old weld. Etching and dye check revealed defects that were blended out to a 10 to 1 ratio. After considerable rework weld quality was acceptable.
A206777 6-28-66	Dye penetrant inspection of special fitting 1 installation for cylindrical tank showed No. 3 porosity, view 4. Grindout is 0.030 by 1/8 in., blended to 10 to 1 ratio, etched, and dye-checked.	No. 3 porosity blended out. Dye check showed defect was removed. After blend, acceptable to Engineering.
A206801 7-20-66	X-ray 66-B80 showed the following: Seam 1, view A, a crack and less dense inclusion; view B, scattered porosity. Seam 2, view A, a crack; seam 3 view A, a crack; view B, linear porosity. Following grindout and X-ray, reweld of seam 2 and 3 was required as depth of grindouts exceeded 0.050 minimum. Dye check showed numerouse grindouts with porosity in seams 1, 2, 3, and 4. X-ray following manual reweld showed a crack and scattered and connected porosities in seam 1, view A; seam 3, view A; and seam 4, view B. Dye check	Porosities were acceptable to Engineering for use. Following grindout and X-ray, seam 1 was acceptable to Engineering for use. X-ray of seam 2 and 3 rewelds accepted; the grindouts were cleaned and manually rewelded. X-ray showed weld quality of seam 1, view B; seam 2, view A and B; seam 3, view B; and seam 4, view A was acceptable. Machining operation was completed per B/P, all seams were X-rayed, dye checked, and etched.

TABLE I, Section 3 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206801 (Cont.)	showed several instances of porosity defects in all four seams. X-ray and dye check, after machining, showed cracks, porosity, and lack of fusion in seams 1, 3, and 4. After blending, seams 1, 3, and 4 showed no indication of defect in rework areas and no change in depths and RMT. There was a total of 48 defects, requiring 24 reworks and six manual rewelds.	Seam 1, view B, scattered porosity; seam 3, view A, cluster porosity, and view B, scattered linear porosity were acceptable to Engineering for use. Remaining defects were ground out, etched for a minute, dye checked, and resubmitted with depths and remaining material thickness (RMT), X-ray 66-B80-AM (after machining), R-1, showed defects removed. Rework acceptable by Engineering for use.
A206815 8-4-66	a. X-ray 66-B92, BM of the ring weld showed the following defects: Seam 2 view C, seam 3, view A, and C, seam 4, view B lack of fusion; seam 3, view A, void. b. Dye check showed: seam 1, view E-E, seam 2, view D-D, seam 3, view E-E, and seam 4, views C-C, D-D, and E-E, cracks. Seam 3, view E-E, No. 3 porosity in grindout.	a. X-ray B92, BM is acceptable to Engineering. b. The defects were ground out, the area etched one minute, dye checked and the depths of the grindouts were measured. The rework was acceptable to Engineering for use.
A212765 5-11-66	Ovality and flatness of cylindrical tank fittings, 1 through 4, exceeded B/P tolerances of maximum ovality, 0.10 in., and maximum flatness 0.005 in.	Acceptable to Engineering for use.
A212673 5-9-66	Dye penetrant inspection showed defects in the following numbered fittings: 1. View 1 to 4, No. 3 porosity. 2. View 1 to 2 and 2 to 3, No. 3 porosity.	Fittings 1, 2, 3, and 4 scraped and ground to remove crater cracks and all No. 3 porosities. Fitting 2 blended area and fitting 3, view 3 to 4, acceptable to Engineering for use. Remaining fittings were smoothed, and

TABLE I, Section 3 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A212673 (Cont.)	3. View 1 to 2 and 2 to 3, No. 3 porosity. View 3 to 4, crater crack. 4. View 2 to 3, No. 3 porosity. View 3 to 4, crater crack. 5. Weld quality acceptable.	blended to a 10 to 1 ratio, etched, and dye checked. Fittings 1, 2, and 4 showed no defects in smoothed and blended areas; fittings 1, 3, and 4 showed no increase in grindouts. Acceptable to Engineering for use.
A216981 8-4-66	As noted on FARR A203622, visual inspection of cylindrical tank seam 4 showed groove to be 0.079-0.080 in. maximum.	Grooved areas were rewelded per DPS 14.052, using parameters for pre-production repair sample. Rework was accepted.
A217090 8-30-66	Visual inspection of aft ring to cylinder weld, showed areas ground below parent metal during removal of dye penetrant as follows: a. Seam 4 toward seam 5 at 30 to 30 3/4 in., two grindouts, -0.002 to -0.008 in. b. Seam 5 toward seam 6 at 12 in., a grind-out -0.005, 1/4 by 3/32 in. c. Seam 6 toward seam 7 at 79 in., a grind-out -0.002, 1/8 by 3/32 in. d. Seam 7 toward seam 1 at 4 1/4 in., a grindout -0.004.	Dye check inspection acceptable after final blending and etching per DPS 15106 and 15101.

TABLE I, Section 3 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220154 9-2-66	Visual inspection of cylindrical tank assembly ring weld showed the following areas ground below parent metal during removal of dye penetrant: a. Outer weld, aft ring to cylinder, -0.005 to -0.018 in., three grindouts. b. Outer weld of forward ring to cylinder, +0.002 to -0.006 in. seven grindouts. c. Inner weld, forward ring to cylinder, from -0.002 to -0.011 in., five grindouts.	a and b. Acceptable after blending, etching and re-dye check of weld; blended areas acceptable to inspection. c. Defects were ground out to remove dye penetrant indications. Blending and etching were acceptable.
A220157 9-7-66	Radiographic inspection of the aft ring to cylinder tank assembly weld showed linear porosity, 46 3/4 in. from seam 4 toward seam 5.	Acceptable to Engineering for use.

TABLE I (Continued)

Section 4. Liquid Oxygen Tank Assembly, P/N 1A39307-525

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206848 8-21-66	Visual inspection of the attach angle 12, seam 3 revealed an oversize hole, 0.320 in. in diameter, which should be 0.302 in. maximum.	The hole was drilled and reamed cut to 0.3225 to 0.3245 in. diameter, and an oversize 1/64 in. lockbolt installed. The rework was acceptable.
A206899 8-23-66	A mismatch was noted between the thrust structure attach angles at heel line of gap 19, 4 in. from seam 7 toward seam 8. The mismatch is 0.012 in.; the maximum is 0.010 in.	Acceptable to Engineering for use.
A220568 9-7-66	Weld stoppage occurred during aft weld of bulkhead to aft dome, 2 1/2 in. from seam 9 toward seam 1.	The X-ray, 66-B106, of the area revealed a void that was acceptable to Engineering for use. The weld was chipped back 6 in. A reweld completed X-rayed, dye-checked; and a post-production sample weld X-rayed, which showed cluster of porosity, acceptable following dye check and tensile test.
A220571 9-8-66	Visual inspection of the common bulkhead to aft dome forward weld of LOX Tank Assembly, P/N 1A39307-457, S/N 1007, showed the following welds 1/32 in. undersize at inboard side: a. Seam 2, 34 to 36 in. b. Seam 6, 1. 52 to 54 in., 2. 58 to 60 in.	Acceptable to Engineering for use.

TABLE I (Continued)

Section 5. Common Bulkhead Assembly, P/N 1A39309-501

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A195579 6-3-66	Dye penetrant inspection of ring assembly of the aft common face, P/N 1A39286-9, S/N 023, showed grindouts views B-B, C-C, and D-D in seam 1; a grindout view B-B in seam 2; and in bottom of grindout view B-B, a crack and porosity and grindout view D-D. Dye check inspection, R-1, showed seam 3, view B-B grindout defects removed.	After grindouts and dye checks, all grindouts were acceptable to Engineering for use.
A195581 6-7-66	X-ray 66-B53 ACS of aft common ring, P/N 1A39286-9, S/N 023, showed a crack at seam 2, view B.	After grinding and manual reweld, and resubmittal of X-ray 66-B53 ACS R1 and dye check, the rework was acceptable to Engineering for use.
A195593 6-20-66	Dye penetrant inspection and X-ray 66-B62BM of ring seam welds, P/N 1A39280-11, S/N 021, seams 1, 2, and 3 showed various porosity defects and cracks. Before completion of weld repairs, X-ray 66-B62, BM, R2, showed seam 1, view A and B acceptable; seam 2 and 3, view A, cracks, repairs incomplete; dye check to be completed before final acceptance.	X-ray defects were ground out and removed, but a dye check was waived because of the excessive depths of the grindouts. Depths were measured and 24 grindouts were acceptable to Engineering for use. The rest were cleaned per DPS 41006 and manually rewelded. Repairs on seams 2 and 3 were completed as follows: Defective segments of seams 2 and 3 were cut out and new segments were cut and trimmed to fit the weld fixture. Ends of the new segments were prepared for welding to the ends of existing segments and welded in per B/P requirements. The completed weld joints were X-rayed, etched, dye checked, and the results resubmitted on FARR A206740.

TABLE I, Section 5 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206739 7-11-66	Visual inspection showed grindouts in the meridian weld, P/N 1A39280-403, S/N 2011, at seams 2, 3, 5, 6, 8, and 7. Depths varied from 0.000 to 0.100 in., and RMT's varied from 0.087 to 0.107 in. Following rework the depths varied from 0.000 to 0.014 in. and the RMT's, from 0.089 to 0.107 in.	Seam 2 defect was ground to a 10-1 ratio, smoothed and blended, etched and dye checked, and the depth and RMT measured. All the others were scraped, etched and dye checked and the depth and RMT measured. After dye check and blend all rework was acceptable to Engineering for use.
A206740 7-11-66	a. X-ray 66-B62, BM, NS of the ring welds, P/N 1A39280-11, S/N 021, following rework described in FARR A195593, showed a crack, view A, seam 3. b. A dye-check showed cracks, seam 3, view B-B and at junction of views C-C and D-D, and porosity, view C-C.	The defects were ground and the areas X-rayed, etched for one minute, and dye-checked. The depths were measured and the rework was acceptable to Engineering for use.
A206774 6-27-66	The unfinished ring seam had a 122.844 radius. The finished OD radius should be 122.931 +.030 -.000. The average of the unfinished ring was -.087. X-ray 66-B53 ACS-2 showed a crack at seam 2, view B, after hot check and straightening rework.	The ring seam was hot checked and straightened per DPS 4.51. A dye-check was acceptable. After rework, the ring radius OD was 122.842, -.089. The crack was ground out; depth was .440 in. A new segment was installed X-ray 66-B53BM showed the welds to be acceptable. Dye check showed no defects.
A206781 6-29-66	X-ray, dye check, and visual inspection of the aft common face meridian welds, P/N 1A39286-403, S/N 2011, showed 0.010 to 0.30 in. mismatch in seam 6, connected porosity in seam 3, mechanical damage in seam 5, connected and cluster of porosity in seam 9.	All defects were corrected by grinding scraping, blending, and a reweld of seam 9. The rework was acceptable to Engineering for use after smoothing, blending to a 10 to 1 ratio, etching, and dye checking grindouts, and measuring depths and RMT.

TABLE I, Section 5 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206784 7-1-66	Inspection of meridian weld segment 9 of the forward face meridian weld, P/N 1A39280, S/N 2011, showed creases in the section, but with no loss of material. a. Aft of the trim line, 50 to 53 in. and 18 to 20 in. from seam 9, maximum depth of 0.050 in. b. Aft of the trim line, 60 to 63 in. and 20 to 22 in. from seam 9, maximum depth of 0.020 in.	a and b. The anodic was stripped from the forward side of the bulkhead crease areas. A dye check inspection showed no defects in the reworked areas. The bare spots were touched up with alodine per DPS 945 and the creases were acceptable to Engineering for use.
A206791 7-6-66	Visual inspection showed spots of black residue and discoloration on the inside surface of segment 9, of the forward face meridian weld, P/N 1A39280-403, S/N 2011. The maximum size of the spots was 3/16 in. in diameter.	The area was lightly sanded and the rework was accepted.
A206830 8-9-66	X-ray, dye check and visual inspection of the aft ring to face weld, P/N 1A39286-401, S/N 2011, showed several instances of grindout, concentrated porosity, voids, clusters of porosity, and fine scattered porosity in seams 1 through 9.	Defects not acceptable to Engineering for use were scraped, ground, cleaned per DPS 41006, and the areas etched, dye-checked, and X-rayed; and the depths and RMT measured. Active grindout, exceeding 0.010 in. in depth were smoothed and blended to a 10 to 1 ratio; those 0.010 in. and less were scraped. All were etched, dye-checked and depths and RMT measured. Rework was acceptable to Engineering for use.
A206833 8-12-66	X-ray 66-B74 of preproduction sample aft dollar, P/N 1A39286-900, S/N 2011, showed linear porosity in views 2, 3, 4, 5, and 6.	Not acceptable to Engineering for use. Instructions given to make another preproduction sample.

TABLE I, Section 5 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206861 7-21-66	Pasa Jell splattered on outside surface of bulkhead approximately midway between forward wall and seams 2, 3, and 5.	The areas where the anodic was removed were touched up with Alodine per DPS 41410.
A206875 8-3-66	Outside ring to face weld had a grindout 26 5/8 in. from seam 7 toward 8.	The grindout was blended to a 10 to 1 ratio, and to an acceptable 0.048 in. depth and 0.056 in. RMT.
A206880 8-11-66	Several Pasa-Jell splatters were on the outside anodized surface of the forward face, P/N 1A39280-403, S/N 1007A, near weld seams.	Acceptable to Engineering for use.
A206885	Dye check of aft skirt assembly ring-to-face weld, P/N 1A39286-401, S/N 2011, showed scattered pits to a depth of 0.010 in. and a maximum diameter of 1/32 in.	Acceptable to Engineering for use following dye check.
A217190 9-16-66	Inspection of aft dome segment 5 of tank assembly, P/N 1A39303-521, S/N 1009, showed the following: a. Inside forward edge was chem-milled from 0.205 to 0.236 in. thick; area width varied from 1/16 to 5/16 in. b. View aft, 12 in. clockwise from seam 6, on the outside surface, 2 in. aft from forward edge, there was a cut in the skin, 1 in. long by 0.002 in. deep, parallel to the edge.	a. Excess roughness was removed, a 63 finish was maintained, and the reworked area cleaned per DPS 41006. b. Scratch was polished out with an aluminum oxide cloth, a 125 finish was maintained, and a depth of 0.003 in. maintained. Rework was acceptable.
A220521 9-2-66	A dye-check of all accessable welds after bond showed linear porosity in seam 3, view D-D, of the aft common ring seam outboard face.	The defect was removed by light scraping. Dye-check revealed a grindout 0.032 in. deep with a 0.331 in. RMT, acceptable to Engineering for use.

TABLE I, (Continued)

Section 6. Aft Dome Assembly, P/N 1A39308-513

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206743 7-13-66	Dye check of the F-F fitting welds showed: a. View 1, inside weld overlap and No. 3 porosity. b. View 3, outside, weld, No. 3 porosity. After rework, a 3/16 in. fillet reduced by 0.010 X 1/2 in. span at skin segment view 1; 0.003 in. maximum material was removed at crown. The defect was removed by blending.	Defects were ground, dye-checked, etched, and dye-checked, and the depths measured. All defects were removed. The rework was acceptable to Engineering for use.
A206750 7-20-66	The following discrepancies were found in the aft dome preproduction sample: a. The tooling PDS preproduction test sample configuration does not conform to the production unit per DPS 14052. b. The test sample is: 1. Machined and it should be chem-milled. 2. Straight and it should be contoured. 3. Made from vendor-supplied T6 material and it should be heat treated by DACo.	Acceptable to Engineering for use.
A206802 7-21-66	X-ray 66-B81 inside weld of the sensor fitting, AK-AK to dome segment showed, view 2, a void.	Acceptable to Engineering for use.

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206805 7-23-66	X-ray 66-B81 of the outside weld of fitting 66 showed voids, linear and connected porosities in views 1, 2, 4, 5 and 6; more dense inclusion and a crack, view 6; lack of fusion, views 1, 2, 3, 4, 5, and 6.	The entire outside weld bead was ground flush, the area cleaned for welding per DPS 41006, and mechanically rewelded. X-ray 66-B81, R1 showed more dense inclusions, views 5 and 6, acceptable to Engineering for use, and a dye-check showed the weld quality acceptable.
A206807 7-23-66	X-ray 66-B81 of L-L flange inside weld showed, view 4, cold lap.	Acceptable to Engineering for use.
A206809 7-27-66	Dye check and visual inspection showed concentrated porosity in seam 2 and grindouts at seven locations along seams 2, 3, 4, 6, and 8, with depths from 0.005 to 0.017 in. and RMT from 0.090 to 0.182 in.	The seam 2 porosity at 1 2 1/4 in. was acceptable to Engineering for use. The grindouts were removed by scraping; the areas were etched and dye-checked; the depths and RMT showed no changes. After blending to a 10 to 1 ratio, the rework was acceptable to Engineering for use.
A206818 8-5-66	X-ray 66-B81 of the AR-AR elbow showed: view 1, a void with crack; view 2, linear and clustered porosity.	The defects were ground out, the area X-rayed and rewelded. X-ray 66-B81, R1, views 1 and 2, showed weld quality acceptable after rework.
A206819 8-5-66	X-ray of the AU-AU elbow showed, views 1 and 2, more dense inclusions.	The weld was ground flush. X-ray 66-B81, R2 showed the defects removed and the depths of the grindouts 0.0075 and 0.096 in. The area was manually rewelded; X-ray 66-B81, R3, views 1 and 2 showed weld quality acceptable after rework.

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206820 8-5-66	X-ray 66-B81 of the F-F elbow, showed: view 1, linear and clustered porosity; view 3, voids.	The defects were ground out and X-rayed to ensure removal, and the area manually rewelded. X-ray 66-B81, R1 showed views 1 and 3, that the weld quality was acceptable after rework.
A206823 8-8-66	Dye penetrant inspection of LH_2 helium heater showed weld 3 No. 3 porosities inside weld. After rework, five grindouts remained with depths of 0.020, 0.031, 0.017, 0.015, and 0.008 in., and RMT's of 0.105, 0.094, 0.108, 0.110, and 0.117 in. After blending, a dye check showed a No. 1 porosity on the edge of one grindout and depths of 0.023, 0.035, 0.020, 0.017, and 0.011 in. and RMT's of 0.102, 0.090, 0.105, 0.108, and 0.114 in.	The No. 3 porosities were ground, etched, dye checked and the depths and RMT's taken. A dye-check showed the defects removed leaving grindouts. After blending, the No. 1 porosity and all blended areas were acceptable to Engineering for use.
A206824 8-8-66	Dye-penetrant inspection of LOX helium heater showed weld 3 cold lap inside weld, and a heat check condition outside weld.	Defects were scraped and ground, etched, dye checked, and the depths and RMT taken. Dye check showed defects were removed. Grindouts with depths of 0.051 and 0.040 in. and RMT's of 0.074 and 0.085 in. were cleaned out per DPS 41006 and manually rewelded. X-ray showed the reweld to be acceptable; a dye check showed three No. 1 porosities, also acceptable to Engineering for use.
A206825 8-8-66	Dye penetrant inspection of LOX chilldown return showed weld 3 No. 3 porosity and connecting porosity inside weld. After rework, four grindouts remained with depths of 0.048, 0.031, 0.026, and 0.019 in. and RMT's of 0.077, 0.094, 0.099, and 0.106 in. After blending, the last three depths were 0.032, 0.026, and 0.021 in., RMT's were 0.093, 0.099, 0.104 in.	The defects were scraped and ground, etched, dye-checked, and the depths and RMT taken. Dye check of AR elbow showed weld 3 defects removed. The 0.048 grindout was cleaned per DPS 41006 and manually rewelded. The other three were blended out to 10 to 1 ratio. X-ray showed the reweld to be acceptable

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206825 (Cont.)		a dye check showed a No. 1 porosity acceptable to Engineering for use. The blends also were acceptable to Engineering for use.
A206826 8-8-66	Dye penetrant inspection of the LH_2 fill line fitting showed cracks and connected porosity, inside weld. Following rework, 11 grindouts had depths to 0.072 in. maximum. Following reweld, X-ray 66-B81 DC showed the weld to be acceptable, and the dye-check showed two No. 1 porosities.	The defects were ground out, etched, dye checked, and the depths and RMT measured. Grindout areas were manually rewelded, X-rayed and dye-checked. Porosities after reweld were acceptable to Engineering for use.
A206834 8-15-66	X-ray 66-B81 of the G-G elbow-to-fitting showed: view 2, undercut 0.005 in. deep by 1/8 in. long; view 4, fine linear porosity.	The undercut was smoothed, etched, dye-checked, and depth checked. The dye revealed no defect after smoothing; the depth remained 0.005 in. The rework was acceptable to Engineering for use. View 4, fine line porosity, was acceptable to Engineering for use.
A206835 8-15-66	X-ray 66-B81 of the AP-AP fitting-to-elbow weld showed, view 1, more dense inclusions.	Acceptable to Engineering for use.
A206837 8-16-67	X-ray 66-B81 of the AU-AU flange-to-elbow fitting showed, view 1, more dense inclusions.	Acceptable to Engineering for use.
A206838 8-16-66	X-ray 66-B81 of the AT-AT flange-to-elbow weld showed, views 2 and 4, more dense inclusions.	Acceptable to Engineering for use.
A206839 8-16-66	X-ray 66-B81 of the AR-AR flange-to-elbow weld showed, views 2, 3, and 4, more dense inclusions. X-ray 66-B81, R1 showed defect removed.	Views 3 and 4 were acceptable to Engineering for use. View 2 defects were ground out to 1/4 X 1 X 0.070 in. deep blendout in fillet weld. RMT at blendout was 0.153. Acceptable to Engineering for use.

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A206840 8-16-66	Dye penetrant inspection of AP-AP flange showed view A, concentrated porosity; view C, a heat check condition in the parent metal adjacent to the weld; and view D, linear indications in two places. As blended view A depth was 3/16 X 1/2 X 0.040 in. deep in fillet weld, view C was blended out 0.003 in. into parent material (minimum is 0.123 in.), and view D was 0.005 in. deep in weld.	Defects were scraped and sanded, etched and dye-checked, and the depths measured. All defects were removed; all blended areas were acceptable to Engineering for use.
A206842 8-16-66	Dye penetrant inspection of AU-AU flange showed, view C, heat check condition in parent metal adjacent to weld.	The condition was removed by scraping and sanding; the area was etched and dye checked; and the depth and RMT measured. The blendout depth in the parent metal is 0.004 in., minimum RMT is 0.122 in. The rework was acceptable to Engineering for use.
A206873 7-31-66	Visual, X-ray, and dye-check inspection of the dome flange weld, seam 1 toward 2, showed a lack of fusion inside; seam 9 toward 1, gouges at weld edge at 8 1/2 in., 0.003 in.; at 9 in. 0.08 in.; and at 9 1/4 in., 0.001 in.; seam 9 toward 1, cracks at weld edge, flange side, at 3 to 4 1/2 in. from seam 8 toward 9. Defects extend into parent metal.	At seam 1 toward 2, the defect was shaved to B/P requirements; no visible evidence of lack of fusion. Seam 9-1 depths after smoothing were 0.006, 0.010, and 0.001 in. Seam 1-2 acceptable to Engineering. Seam 9-1, after scraping, blending, dye check, R1 showed defects removed. Rework acceptable to Engineering for use.
A206894 8-18-66	Contour checks revealed an out-of-tolerance accumulation from 0.006 to 0.070 in. from weld distortion.	All anomalies were acceptable to Engineering for use.

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220503 8-23-66	Dye check of inside surface of flange of aft dome doubler installation, P/N 1A39308-513, S/N 1007A, showed machine tears in meridians 2 and 7 adjacent to flange weld. Resubmit of dye penetrant showed defects noted were removed.	Defect areas scraped, etched, dye-checked, and depths and RMT resubmitted. Rework was acceptable to Engineering for use.

TABLE I, (Continued)

Section 7. Forward Skirt Assembly, P/N 1A39264-501

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A228271 11-4-66	Discrepancies in forward skirt assembly, P/N 1A39264-501, S/N 1009, stringers were noted as follows: a. Stringer 58, station 615.702, a hole was drilled in ring frame with an edge distance of 1/4 in. Minimum edge distance should be 1/16 in. b. Stringer 45, station 581, was incorrectly milled, short by 5/8 in., interfering by extending 1/32 in. into top of lockbolt hole.	a. Acceptable to Engineering for use. b. 3/16 hole, 3/8 in. diameter on stringer 45, station 647, was spot-faced to allow 90 per cent bearing under the lockbolt head. Rework was acceptable to Engineering for use.
A228482 11-14-66	On stringer 2, 15 1/2 in. forward of aft interface, one 5/32 in. hole was countersunk 0.325 in., maximum is 0.249 in. to accommodate dimple forward skirt skin, P/N 1A39264-125, S/N 1009, for rivet P/N 1097-DD5.	Rivet material, P/N MS20426AD6, was installed. Rework was acceptable.
A233422 12-12-66	At station 515.625, stringer 13-14 of forward skirt assembly, P/N 1A39264-501, S/N 1009, showed the following: a. Six No. 40 holes were drilled into 1B57026-11NC and 1B57026-13NC brackets. No holes should have been drilled. b. Eight No. 40 holes were drilled into bracket assembly, P/N 1B57026-401. To conform to B/P 1B57026NC, no No. 40 holes should have been so drilled.	Holes were plugged with rivet material, P/N MS20426AD3. Rework was acceptable.

TABLE I, Section 7 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A233600 1-31-67	Inspection of forward skirt, panel A99 between stringers 25 and 26, showed the following defects in the grommets of J1 and J2 receptacles to internal wire harness 411A99A10W1, P/N 1B34485-1D, the pins R and M (J1) and pins Z, R, J, H, P, X, and F (J2) are recessed and damaged.	All pins were removed from the J1 and J2 receptacles, all damaged pins were replaced per DPS 54002-5, table 3, and connected to new replacement receptacles. The pins were securely installed per B/P requirements, and the connectors mated three times. Rework was acceptable to Engineering for use.

TABLE I, (Continued)

Section 8. Aft Skirt Assembly, P/N 1A39295-515

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A220416 10-10-66	On aft skirt frame segment, P/N 1A83217-401K, fifty-six 0.384-0.394 in. diameter holes oversize to 0.404 in. were drilled.	Acceptable to Engineering for use.
A228369 1-10-67	On the receptacle J1 of internal wire harness, P/N 404A2W1, pins M, F, and Z were poorly recessed after mating with connector P1 of wire harness, P/N 404W15.	Receptacle was removed and replaced.
A233405 12-1-66	To the aft skirt frame installation, P/N 1A94404-1, at station 256.500, sealant, P/N DPM 2292-4, was applied in the following areas: a. For the entire inner circumference of the aft skirt. b. Four splices, two ends each splice (8 places), P/N 1A98600-1NC. No sealant should be in these areas per B/P 1A39295 CG, view E, zone 8.	Acceptable to Engineering for use.

TABLE I, (Continued)

Section 9. Thrust Structure, P/N 1A39316-511

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A188544 2-3-67	At stringer 22, 16 3/8 in. below attachment ring, a standoff was missing on the thrust structure. Ref. B/P 1A39613-501, sheet 13, and electrical routing B/P 1B42498-1, p. 67, item 13, on cable 404W201.	Bracket, P/N 1B55253-1, was installed and attached to the stringer. The rework was acceptable.
A233410 12-5-66	At aft end of stringers 121, 123 and 125 of thrust structure assembly, P/N 1A39316-517, S/N 1009, at all but two stations, ED are short, ranging from 3/16 to 3/8 maximum (ED should be 7/16 per B/P 1A39316-R, view A-A, zone 6).	All holes were pulled out to size. Acceptable to Engineering for use.
A233593 1-26-67	a. Standoff, P/N 1B37286-501, at stringer 10 on thrust assembly 16 13/16 in. from end of stringer to attachment, should be 16 3/16 in. per B/P 1B37207, view E, zone 12. b. Standoff, P/N 1B37286-503 at stringer, 8 3/4 on thrust assembly 10 11/16 in. from end of stringer to attachment, should be 12 7/16 per B/P 1B37207, view A, zone 9. Both standoffs are in blind areas and inaccessable.	a. The pipe assembly to be supported by the standoff was installed at the existing standoff without the attachment, using B/P hardware. The resulting minor cocking of the clamp was acceptable to Engineering, AFQC concurring with the disposition and the rework. b. The pipe assembly clamp was reversed, and bracket, P/N 1B55253-1, installed so as to pick up the reversed clamp. The bracket was attached to the stringer with two rivets, P/N MS20470AD5, while a 2-diameter edge distance was maintained. The rework was acceptable.

TABLE II. PERMANENT NONCONFORMANCES AND FUNCTIONAL FAILURE AND REJECTION REPORTS DURING STAGE SYSTEM CHECKOUTS

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A159325 3-14-67	Per Minneapolis-Honeywell TWX dated 3-7-67, the spot welds on fixed mount sleeve, P/N 973500, were suspected of being inadequate. The sleeve was part of the LH_2 mass sensor, P/N 1A48431-505, S/N D3.	The sensor was removed and reworked per the salvage instructions of SEO 1A48431-009. It was then reinstalled in the stage per B/P. The rework was acceptable.
A228562 3-3-67	At location 404A62A214, pin C of plug P14 on wire harness 404A62W200, P/N 1B58249-1, was bent 10° and recessed 1/8 inch. Defect noted during continuity check, H&CO 1B59780.	The bent pin was removed and replaced. The rework was acceptable for use.
A228563 3-6-67	The engine control and bus switching module, P/N 1A74890-501, S/N 113, had resistance measurements of 50 ohms and 20 ohms during the umbilical interface compatibility check, H&CO 1B59782. Both measurements should have been 5 to 15 ohms.	Module S/N 113 was removed and S/N 105 was installed on the stage. Retest of S/N 113 per A659-1A87210-PDS1CT8 showed no malfunctions. The unit was acceptable for further use.
A228564 3-3-67	On plug J2 of decoder assembly 404A62A214, P/N 1A74053-503, S/N 270, the rubber insert was punctured between pins B and C. Defect noted during continuity compatibility check, H&CO 1B59780.	Decoder S/N 270 was removed and S/N 338 was installed. The plug was reworked to meet B/P requirements, and decoder, S/N 270, was accepted for use.
A228565 3-7-67	PCM/DDAS assembly 411A97A200, P/N 1A74049-511, S/N 3, had an output of 5.035 to 5.056 vdc, should have been 5.000 ± 0.030 vdc. Defect noted during the DDAS calibration, H&CO 1B66563.	The unit was reconfigurated to P/N 1B52720-501 for resubmittal and necessary rework. A new PCM/DDAS assembly, P/N 1A74049-511, S/N 14, was installed on the stage.
A228566 3-7-67	20 vdc excitation module 404A63A241, P/N 1A74036-1.1, S/N 0282, had output of 26.658 vdc when tested per H&CO 1B64681. Output should have been within 0.005 vdc of 20 vdc.	After retest, the module was scrapped. 20-volt excitation module, S/N 0289, was installed in its place.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A228567 3-8-67	PCM RF assembly 411A64A200, P/N 1B52721-509, S/N 33, had no output power during the T/M and RS antenna check, H&CO 1B64679. The output power should have been 15 watts minimum.	The unit met requirements during retest, and was acceptable to Engineering for use.
A228568 3-8-67	The output of multiplexer 404A61A200, P/N 1B62513-529, S/N 19, was intermittently 4.969 vdc, should have been 5.00 ± 0.03 vdc. Defect noted during the DDAS calibration, H&CO 1B66563. During trouble-shooting on the stage, 28 vdc was inadvertently applied to pin E of connector J6, the calibrator 5 vdc input.	Laboratory retest did not confirm the defect, but retest on the stage did confirm it. The unit was removed and S/N 17 was installed on the stage. Due to the application of 28 vdc, calibration card, P/N 50M65020-3, S/N 17B, was inoperative and was removed and replaced by S/N 65B. After retest, the multiplexer was accepted for further use. (Reference FARR A248645).
A228569 3-9-67.	Check valve, P/N 1B40824-505, S/N 154, leaked 45 scim with 28 ± 3 psig applied during propulsion component internal leak check per H&CO 1B59455. Maximum allowable leakage was 20 scim. Leakage measured on flow meter valve attached to 1-1/4 inch line, P/N 1B55285, on thrust structure.	The defective check valve, S/N 154, was replaced by check valve, P/N 1B40824-505, S/N 156. S/N 154 was reworked to applicable B/P specifications or replaced by the vendor.
A228570 3-10-67	At thrust structure stringer 6, heavy leakage was noted at the LH_2 pressure check valve, P/N 1B65673-1, S/N 21, and at the B-nut on LH_2 pipe assembly, P/N 1B64112-1. Both leaks were due to scored flare surfaces. Defects noted during the LH_2 tank pressurization system leak check H&CO 1B59456.	The check valve was removed and dispositioned by FARR A228572. Check valve, P/N 1B65673-1, S/N 5, was installed. The pipe assembly flare was polished (reference FARR A228573) but leakage continued. The pipe assembly was found to be out of round, and was replaced by a new pipe assembly, P/N 1B64112-1.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A228571 3-10-67	Range safety decoder 411A99A1, P/N 50M10698, S/N 0135, failed during the power distribution system test, H&CO 1B66562. Pin 38 of receptacle J1 was found to be bent over.	The decoder was returned to government stores for rework to specs. Decoder, P/N 50M10698, S/N 92, was installed at 411A99A1.
A228572 3-10-67	At aft thrust structure stringer 6A, LH_2 pressure check valve, P/N 1B65673-1, S/N 21, had a damaged and scored flare. This caused leakage, as noted during the LH_2 tank pressurization system leak check, H&CO 1B59456. (Reference FARR A228570).	The check valve was replaced on the stage by S/N 5. The damaged flare was reworked to B/P requirements or replaced by the vendor.
A228573 3-10-67	At thrust structure 6, pipe assembly, P/N 1B64112-1, leaked at the B-nut due to scratches in the flare surface. Defect noted during the LH_2 tank pressurization system leak check, H&CO 1B59456. (Reference FARR A228570).	The flare surface was polished to an acceptable condition. (Per FARR A228570, the pipe assembly was later found to be out of round, and was scrapped.)
A228574 3-10-67	On wire harness 404A3W1, P/N 1B34883-1, S/N 02, wire P222H20 installed between pin H, plug P22, and pin k, plug P18, should not have been installed in that location per B/P. Defect noted during the power distribution system test, H&CO 1B66562.	The wire was removed, reterminated per B/P, and megger checked. The rework was acceptable.
A228575 3-11-67	The amplifier of transducer kit 403MT751, P/N 1B53573-507, S/N 507-7, failed during the DDAS test, H&CO 1B66564. High RACS was -0.025 vdc, should have been 4.0 ± 0.1 vdc; low RACS was -0.021 vdc, should have been 1.0 ± 0.1 vdc; and ambient was -31.5 psig, should have been 0 ± 1.2 psig.	The transducer kit was returned to the vendor for rework or replacement. Transducer kit S/N 507-9 was installed on the stage.
A228580 3-27-67	There were two burned spots on helium sphere, P/N 1A49990-505, S/N 97, located 4 in. from the neck of the bottle.	The helium sphere was removed and replaced. The rework was acceptable.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A228592 4-17-67	During the final inspection leak check per A659-1B65763-1PATP6, excess leaks were found in the LOX chilldown return line, P/N 1A87736-1, at the thrust structure to dome joint; in the LH_2 chilldown return line from the pump to the prevalve, at the upstream end of duct, P/N 1A49966-501, outside the aft skirt; and in the LH_2 chilldown return line at the downstream end of P/N 1B59760-1, inside the aft skirt.	The leaking fittings were disassembled and the sealing surfaces were inspected. No visible damage was found. The sealing gaskets were replaced, and the fittings were reassembled and retested. No further leaks were noted and the fittings were accepted for use.
A243628 2-8-67	On thrust structure stringer 12A, standoff, P/N 1B37286-503, was installed 1-5/8 in. too far aft. The standoff was 18-1/4 in. from the interface, should have been 16-5/8 in.	The standoff was trimmed, leaving the base attached to the stringer. A clip, P/N 1B55253-1, was installed on the stringer, and the pipe support angle was attached to the clip. A clip was added to pick up the pipe assembly. The rework was accepted.
A243629 2-8-67	The supports, P/N 1B27099, installed on the LOX dome for the tunnel run, had no locking devices for bolts. Inserts, P/N NAS 1394C4, were installed 30 places instead of the required inserts, P/N NAS 1394C4L.	The support blocks were installed using B/P bolts except with the heads drilled 0.046 ± 0.010, -0.000 in. for lockwire. The bolts were lockwired together in pairs per DPS 13300. The rework was acceptable.
A243637 2-17-67	The cable for transducer 425MT601 had a 1/2 in. tear in the outer insulation, located below the auxiliary tunnel, 5 in. above the last clip before the cable termination. The cable shielding was not damaged.	The damaged area was wrapped with DPM 2766 teflon tape per DPS 54010. The rework was accepted.
A243644 2-23-67	Panel, P/N 1A88924-1, was located 44.759 in. from the thrust structure attachment angle, P/N 1A39316-5; should have been 44.893 in.	The upper edge of the panel was trimmed as required to clear the helium bottle turn buckles by 1/32 to 1/16 in. The rework area was finished to match

TABLE III, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A243644 (CONT.)		the remainder of the panel edge, and accepted for use.
A243645 2-23-67	500 vdc from a type 1862C megohmeter was applied to connector 424A3J1 on pump, P/N 1A49421-503, S/N 162, and to connector 424A2J1 on pump, P/N 1A49423-505, S/N X1763, when plugs P1 on wire harness 404W26, P/N 1B56369, and P1 on wire harness 404W27, P/N 1B58984, were accidentally tested during the testing of wire harness 404W7, P/N 1B64948-1.	Acceptable to Engineering for use. The megohmeter drew only 10 ma under short circuit conditions, while each phase of the pump motors could carry 80 amps.
A243646 2-24-67	At aft skirt panel position 10, between stringers 98 and 103, fasteners were mounted on the panel, P/N 1B58926-1, with a 2.75 in. dimension, rather than the 2.00 in. dimension required by SEO 1B58926-001. This prevented installation of an amplifier.	Fasteners were relocated and installed per the SEO. The mislocated fastener was not removed. The rework was acceptable.
A243647 2-27-67	The LH_2 feed duct, P/N 1A49320-507, S/N 42R, had a ding 1 in. by 1/2 in., 1/8 in. deep, across the upstream end weld seam.	Acceptable to Engineering following a dye check of the area.
A243648 2-27-67	Support, P/N 1B40998-1, was 1 1/4 in. forward of stringer 20, causing interference with electrical plug installation. The support should have been 13/16 in. forward of stringer 20 per B/P 1B39841.	The support was relocated per B/P requirements. The open bolt holes remaining were acceptable to Engineering. The rework was acceptable.
A243650 3-1-67	In the aft skirt, the coaxial cable of transducer 404MT629 had fourteen 1/32 in. nicks, one 1/2 in. nick, and one 1/4 in. cut in the outer insulation along the length of the cable. The cable shielding was not damaged.	The damaged areas were wrapped with teflon tape. Where damaged areas were so close that the tape overlapped, one continuous wrap was used. The rework was acceptable.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A243701 2-15-67	In the thrust structure area, panel, P/N 1B57301-1, extended 9/16 in. left toward stringer 23, and 7/16 in. right toward stringer 1, should have been 1/2 in. each side per B/P 1B56214. The condition prevented the installation of electrical plug P2.	Tee, P/N 1B56214-11, and shim, P/N 1B56214-21, were trimmed 3/32 in., to clear plug P2 by 1/32 in. Panel, P/N 1B57301-1, was not cut or damaged. The rework area was finished to 125 rms, alodined per DPS 41410, and finished per specification F289. The rework was acceptable.
A243704 3-1-67	In the aft tunnel, three wire harness feed-through receptacles, two P/N 50470F10, and one P/N 50470F11, were not positioned (clocked) on plate, P/N 1B65576-1, per B/P 1B39247 requirements.	Acceptable to Engineering for use.
A243706 3-2-67	At the installation of manifolds, P/N 1B66241-1, 1B66242-1, 1B66243-1, 1B66244-1, 1B66245-1, and 1B66246-1, to the ten helium spheres, numerous cases of hand forming, overstress, kinks, misfits, and a rotational preload were noted. The hard forming violated the requirements of DPS 10003.	All of the defective lines were removed and proof tested. Any lines not passing the proof test were replaced, and the lines were reinstalled per B/P and DPS requirements.
A248520 4-22-67	The following defects were noted during final inspection: In the forward skirt, on wire harness 411W11, P/N 1B58983, plug P2, mating to 411A92A24J1, had pin 11 recessed 0.036 in. In the aft skirt, on wire harness 404W208, P/N 1B58324, the plug mating to 404A63A221J1 had pin 10 recessed 0.045 in., and plug P106, mating to 404A63A223J1, had pin 11 recessed 0.040 in. Per DPS 54002-10 and WRO S-IVB-3348-R4, the pins should have been recessed 0.065 ± 0.015 inches.	Acceptable to Engineering for use.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248626 3-13-67	At thrust structure stringer 6, pipe assembly, P/N 1B64882-1, had a leak at the weld upstream of the tee. Defect noted during the pneumatic control system leak check, H&CO 1B59457.	The weld was ground out and rewelded. After an x-ray check and a pressure test per 1B64882, the weld showed no leakage. The rework was acceptable.
A248627 3-13-67	The flare seating area of pipe assembly, P/N 1B64137-1, was damaged on the upstream side.	The flare was polished per DPS 10001, cleaned, and accepted.
A248628 3-13-67	On the upstream side of pipe assembly, P/N 1B52413-1, the flare seating area was damaged.	The flare was polished per DPS 10001. The rework was acceptable.
A248629 3-13-67	On the downstream end of pipe assembly, P/N 1B58807-1, the fitting seating surface was damaged.	The surface was polished per DPS 10002, and cleaned per DPS 43000. The rework was acceptable.
A248630 3-14-67	On the J2 engine, P/N 103826, S/N J2094, transducer 3MTP5, P/N NA5-27412T15T, S/N 6148A, failed during the DDAS test, H&CO 1B66564. High RACS was 3.810 vdc, low RACS was 0.820 vdc, and ambient was -25.692 psia, should have been 4.050 ± 0.1 vdc, 1.050 ± 0.1 vdc, and 14.7 ± 30.0 psia, respectively.	The defective transducer was removed and replaced to meet B/P requirements.
A248631 3-17-67	On the LH_2 tank vent valve, the interim use directional control valve, P/N 1A49988-1-002, S/N 22, was suspected of being contaminated with particles from a broken gate seal. As the valve had been cycled on the stage, possible system contamination was also suspected. The valve had been previously rejected by FARR's A229868 and A241902.	The interim use valve was removed. Visual examination of the system showed no evidence of contamination. A new directional control valve, P/N 1A49988-1 was installed.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248632 3-20-67	The stage aft dome failed the propellant tank system leak check, H&CO 1B59459, because of leakage at the LOX chilldown pump interface seal to the tank. The outside diameter external edge of tank flange -57 had two 3/8 in. x 0.060 in. maximum gouges on the flange face, and the inside diameter external edge of the same flange had one 5/8 in. x 0.050 in. maximum gouge on the flange face.	The flange sealing surface was machined down 0.030 in. to the required flatness and finish. After reassembly, the leak check was satisfactorily accomplished. The rework was acceptable to Engineering for use.
A248634 3-21-67	Approximately 2 in. of seal was broken off the main valve flapper of the LH_2 directional control valve, P/N 1A49988-1-002, S/N 0022.	The valve was removed and returned to the vendor for rework. Directional control valve, P/N 1A49988-1, S/N 23, was installed at 411A29.
A248635 3-27-67	The required calibration curves were not available for transducer 406MT660, P/N 1A67862-505, S/N 241, measurement C368, and transducer 403MT600, P/N 1B43320-511, S/N 1-4C, measurement D50. (Ref. FARR's A248636 and A248637).	The transducers were removed and replaced. The new transducers were tested and accepted for use.
A248636 3-28-67	Calibration curves were not available for transducer 406MT660, P/N 1A67862-505, S/N 241, located on LOX probe, P/N 1A69275-509-002, S/N 3, and wire harness, P/N 1B42499-401.1, S/N 2. (Reference FARR A248635).	The transducer was removed and replaced. The rework was acceptable.
A248637 3-28-67	Calibration curves were not available for pressure transducer 403MT600, P/N 1B43320-511, S/N 1-4C, measurement D50. (Ref. FARR A248635).	The transducer was removed and replaced. The rework was acceptable for use.
A248638 3-28-67	Foreign material was adrift inside duct assembly, P/N 1A87740-1, inside the aft thrust structure. The duct assembly should have been LOX clean.	The duct assembly was cleaned and processed per DPS 43000 to an acceptable condition.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248639 3-30-67	Pipe assembly, P/N 1B66245-1, had a radial scratch across the flare surface. A leak detected during the repressurization system leak check, H&CO 1B59460, could not be stopped.	The scratch was blended out to meet B/P requirements for the flare. The rework was acceptable.
A248641 3-31-67	A relief override open solenoid on the fuel tank continuous vent valve module, P/N 1B51753-501-007, S/N 009, was energized for a period exceeding 1/2 hour. Maximum allowable duration was 10 seconds per the propellant tank system leak check, H&CO 1B59459. Defect noted during the stage power turn on, H&CO 1B66560.	Acceptable to Engineering for use. The vent valve module was an interim use item and was to be replaced following stage checkout.
A248642 3-31-67	LH_2 fill and drain valve, P/N 1A48240-505, S/N 41, had a blade shaft seal leakage of 19 scim; should not have exceeded 6.1 scim. Defect noted during propellant tanks leak check, H&CO 1B59459.	The valve was removed, and a new fill and drain valve, P/N 1A48240-505, S/N 118, was installed.
A248644 4-4-67	Multiplexer assembly 404A61A200, P/N 1B62513-529, S/N 17, malfunctioned during the DDAS test, H&CO 1B66564. Channel CP1-B0-05-02 meausred 0.185 vdc, should have been 0.0 ± 0.075 vdc.	The multiplexer was removed and routed to the component test lab. Multiplexer S/N 19 was installed on the stage. Retest of S/N 17 per B/P 1B37743 did not confirm the defect. The multiplexer was accepted for further use.
A248645 4-5-67	Multiplexer 404A61A200, P/N 1B62513-529, S/N 19, malfunctioned during the DDAS calibration, H&CO 1B66563. The output was 4.969 vdc, should have been 5.000 ± 0.030 vdc. The multiplexer was previously rejected on FARR A228568 for the same problem.	Acceptable to Engineering for use.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248646 4-6-67	Pressure transducer 403MT664, P/N 1B39293-1, S/N 28, for measurement D88, channel CP1B0-14-05, failed during the DDAS test, H&CO 1B66564. The measured value was 4.122 vdc, should have been 4.000 ± 0.100 vdc.	The transducer was removed and replaced by S/N 36. The rework was acceptable.
A248647 4-5-67	PCM RF assembly 411A64A200, P/N 1B52721-509, S/N 33, had noise spikes on the output signal exceeding 20 per cent of the pulse amplitude. Noise should not exceed 5 per cent per specification control drawing 50M50263. Defect noted during the all systems test, H&CO 1B66571.	The assembly was returned to the vendor, and assembly S/N 34 was installed.
A248648 4-8-67	Power detector, P/N 1A74776-501, S/N 2-0136, failed during the all systems test, H&CO 1B66571. The detector reading was 13.2 millivolts, should have been 13.4 millivolts minimum.	The power detector was removed, and detector, S/N 2-0178, was installed.
A248649 4-11-67	On the engine pump purge module, P/N 1A58347-505, S/N 63, the shutoff valve cycled rapidly. The inlet orifice diameter was 0.024 in.; should have been 0.018 in. These defects were observed during the all systems test, H&CO 1B66571.	The module was removed from the stage and replaced by S/N 71. The rework was acceptable.
A248650 4-11-67	Pressure switch, P/N 1B52623-515, S/N 014, cycled two times per second for 10 minutes. It should have cycled one time per second. This problem was noted during the all systems test, H&CO 1B66571, during umbilicals out run 1.	The switch was removed and replaced by S/N 015. The rework was acceptable.
A248651 4-11-67	At pressure switch 403S2 on the thrust structure, the grommet in plug 403W8P32, on wire harness, P/N 1B63296-1, was damaged at pin D. Defect noted during all systems test, H&CO 1B66571.	Plug 403W8P32 was removed and replaced. The rework was acceptable.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248652 4-13-67	During the all systems test, H&CO 1B66571, measurement D182, transducer 409MT649, P/N 1B40242-569, S/N 569-2, and measurement D218, transducer 403MT750, P/N 1B53574-501, S/N 501-19, had noise levels of 2.5 per cent over 1 second, while measurement D576, transducer 410MT601, P/N 1B40242-509, S/N 509-16, had a noise level of 71 per cent over 1 second. The peak-to-peak noise level should not exceed 2 to 5 per cent for 1 second duration per report SM 46847, used for evaluating open loop telemetry test data.	Acceptable to Engineering for use.
A248702 3-14-67	Engine driven hydraulic pump, P/N 1A66240-503, S/N X457803, installed in isolator, P/N 1A86847-509, S/N 0033, had shaft seal leakage and grooves in the shaft.	The pump was removed and replaced. The rework was acceptable.
A257902 5-26-67	Relay control package 404A51A4, P/N 1B57731-1, S/N 337, did not show evidence of acceptance testing. Test data per drawing 1B53606 and a completed fabrication order covering the test should have been on file.	The attaching hardware was removed, and the assembly faying surface was checked for buy-out stamps. The package was found to have been tested acceptably, and was accepted for use.
A257907 6-12-67	During the GN_2 purge, H&CO 1B65783, when the LH_2 vent switch was actuated using the GSE, a fuse blew. It was suspected that the short which caused the fuse to blow was in the stage wiring.	A continuity check was performed on wire harness 411W6P2 to 411A99A10J8. The results of this check were pending at the time of turnover and the FARR was transferred open to STC.
A261101 5-5-67	One support assembly, P/N 1B37286-503, was missing at stringer 6A on the thrust structure. Defect noted during post checkout modification.	A clip, P/N 1B53563-47, was installed with two rivets, P/N BJ5, to pick up the wire run clamp at the noted stringer location.

TABLE II, (CONTINUED)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261102 5-5-67	The existing No. 10 holes on thrust structure stringer 11-3/4 could not be picked up for the installation of support bracket, P/N 1B37207-99, for pipe assembly P/N 1B66839-1. The support missed one hole entirely, and one hole fell in the center of the support. Defect noted during post checkout modification for the helium heater installation.	A B/P attachment was used to pick the hole in the clip center. The missed hole was plugged with AD rivet material, and a second attachment was installed through the clip to obtain a center spacing of 5/16 in. minimum from the plug or the installed rivet, and to maintain a 1-1/2 diameter minimum edge distance. The rework was acceptable.
A261103 5-12-67	At the forward end of aft skirt stringer 121A, the center line of clip, P/N 1B54542-15, was 7 in. above the rivet pattern centerline; should have been 4-15/16 in. above the rivet pattern centerline.	The clip was relocated per B/P. Excess holes in the stringer were plugged with AD rivet material. The rework was acceptable.
A261104 5-25-67	There was a sharp dent in tube 164 in the J-2 engine, P/N 103826, S/N J-2094, located 2 in. below hatband 6. The dent, measuring 0.038 in. in depth, was noted during final inspection.	The dented area was brazed by R/NAA personnel, per R/NAA repair procedure. The rework was acceptable.
A261105 5-25-67	The following defects were noted during final inspection of the aft skirt area: a. Standoff, P/N 1B37428-513, on panel, P/N 1B58924-1, was broken, at stringer 59. b. At stringer 98, station 200, one excess 3/16 in. hole was drilled through bracket, P/N 1B52940-1.	a. and b. Acceptable to Engineering for use.

APPENDIX IV

FLIGHT CRITICAL ITEMS INSTALLED AT TRANSFER

APPENDIX IV

FLIGHT CRITICAL ITEMS INSTALLED AT TRANSFER

The Flight Critical Items (FCI) installed on Stage 504N at the time of stage transfer to STC are presented in tabulated form in this Appendix.

The tabulation column headings are identified as follows:

PART NUMBER: Douglas FCI part number.

CL: Applicable change letter of the installed FCI.

SER NO.: Serial number of the installed FCI.

MEAS NO.: Measurement number if applicable, otherwise identification as FCI. TDI designates Time Data Item, ACI designates Age Control Item.

REF LOCATION: Reference location of the FCI on the stage.

CHART-JOB: Identification of the Douglas planning paper (AO) that installed the FCI.

DATE: Date the FCI was installed on the stage.

LOC: Douglas location where FCI installation was accomplished.

N-A PART NO.: Douglas part number of the next higher assembly containing the FCI.

N-A SN: Serial number of the next higher assembly, where applicable.

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1A48240-505	NC	0001	FCI	404A7	24AS0	20	7A20	2	1A39321	NA	5N4
1A48240-505	NC	0118	FCI	427A8	12C00	REM	7D01	2	1A39322	NA	5N4
1A48257-511	NA	0039	FCI		22FS0	150	7C06	2	1A39322	NA	5N4
1A48312-505	NA	0023	FCI	424A1	20SA0	30	7B28	2	1A39321	NA	5N4
1A48430-509-011	NA	C1	FCI				7D17	2		NA	5N4
1A48431-505-008	NA	D3	FCI			00P	7D13	2	1A49951	NA	5N4
1A48857-501	P	36	FCI	403A73		00P	7C22	2	1B58003	NA	5N4
1A48858-1	NA	1063	FCI	TDINA	24TA0	5	6L06	2	1A57523	NA	5N4
1A48858-1	NA	1069	FCI	TDINA	24TA0	5	6L06	2	1A57523	NA	5N4
1A48858-1	NA	1093	FCI	TDINA	24TA0	1	6L07	2	1A57523	NA	5N4
1A48858-1	NA	1112	FCI	TDINA	24TA0	1	6L07	2	1A57523	NA	5N4
1A48858-1	NA	1113	FCI	TDINA	24TA0	1	6L07	2	1A57523	NA	5N4
1A48858-1	NA	1120	FCI	TDINA	24TA0	1	6L07	2	1A57523	NA	5N4
1A48858-1	NA	1125	FCI	TDINA	24TA0	1	6L07	2	1A57523	NA	5N4
1A48858-1	NA	1135	FCI	TDINA	24TA0	5	6L06	2	1A57523	NA	5N4
1A48858-1	NA	1140	FCI	TDINA	24TA0	5	6L06	2	1A57523	NA	5N4
1A49421-503	NA	162	FCI	403A3A41	20SA0	40	7B02	2	1A59098	NA	5N4
1A49423-507-009	NA	1763	FCI	TDI424A4		REM	7C28	2	1A59098	NA	5N4
1A49590-515	AR	545	FCI		20SA0	30	7E22	2	1A39321	NA	5N4
1A49591-529	NA	132	FCI		21FS0	15	7C08	2	1A39322	NA	5N4
1A49964-501	NA	255	FCI	403 POS 1	19SA0	10	7A26	2	1A59098	NA	5N4
1A49964-501	NA	256	FCI	403 POS 1	19SA0	10	7A26	2	1A59098	NA	5N4
1A49965-519	NC	0404	FCI	S1 S2	20SA0	40	7B02	2	1A59098	NA	5N4

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1A49965-521	NA	0303	FCI	S1 S2	19SA0	15	7B01	2	1A59098	NA	5N4
1A49968-507	NA	022	FCI	404A44S1 S2	20SA0	35	7B06	2	1A39322	NA	5N4
1A49968-509	AB	124	FCI	ACI424A6	19SA0	35	7B01	2	1A39321	NA	5N4
1A49988-501	NA	0025	FCI			00P	7E02	2	1A39322	NA	5N4
1A49990-505	M	89	FCI	POS 4		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	90	FCI	POS 1		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	92	FCI	POS 8		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	96	FCI	POS 3		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	98	FCI	POS 7		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	99	FCI	POS 6		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	100	FCI	POS 2		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	102	FCI	POS 9		00P	7C30	2	1B51444	NA	5N4
1A49990-505	M	103	FCI	NO 5		00P	7E01	2	1B51444	NA	5N4
1A49990-505	M	104	FCI	POS 10		00P	7C30	2	1B51444	NA	5N4
1A49991-1	NA	27	FCI		23TS0	55	7A27	2	1B58006		5N4
1A57350-507-002	NC	0227	FCI	403A73A5	23TS0	25	7A20	2	1B58003		5N4
1A58345-515	AB	1053	FCI	ACI403A73A1	23TS0	25	7A17	2	1B58003		5N4
1A58347-505	W	064	FCI	403A73A2	23TS0	25	7A17	2	1B58003	NA	5N4
1A58347-505		071	FCI	403A75A2	22TS0	10	7D11	2	1B58003		5N4
1A59358-525	BG	013	FCI	411A92A6	23FS0	75	7A16	2	1B55394-503	NA	5N4 S
1A59562-505	NA	1033	FCI	11A92A6A11R1		A0	6K30	2	1A59361-503	021	5N4
1A59562-505	NA	1035	FCI	11A92A6A11R2		A0	6K30	2	1A59361-503	021	5N4
1A66212-505.3	AG	018	FCI	411A92A7	23FS0	75	7A06	2	1B55394-503	NA	5N4 S

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1A66240-503	NA	X457806	FCI			FO	7C18	2	1A86847-509	050	5N4
1A66241-511	NA	X454590	FCI	TDI		00P	7E16	2	1B62563	NA	5N4
1A66248-505-011	A	52	FCI	403A71A1	15SA0	00P	7C01	2	1A66248	NA	5N4
1A66248-505-011	A	63	FCI	403A72L1	15SA0	00P	7C01	2	1A66248	NA	5N4
1A68085-505	NA	0056	FCI	411A99A10A1	23FS0	100	6J20	1	1B51379-511	06	5N4
1A68085-505	NA	0095	FCI	404A45A1		A0	6J26	1	1B51211-505	09	5N4
1A74039-517	AJ	017	FCI	404A74A2	25AS0	00P	7B17	2	1B55397	NA	5N4 S
1A74039-517	AJ	046	FCI	404A74A1	25AS0	00P	7B17	2	1B55397	NA	5N4 S
1A74211-503	W	0358	FCI	404A3A19	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74211-505	V	00247	FCI	A48		00P	7E08	2	1B66933	NA	5N4 S
1A74211-505	W	00355	FCI	A8		00P	7E08	2	1B66933	NA	5N4
1A74211-505	W	0381	FCI	404A3A41	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74211-505	W	0383	FCI	404A2A6	25AS0	230	6J26		1B51354-507	07	5N4 S
1A74211-505	Y	0411	FCI	404A45A7		A0	6J26	2	1B51211-505	09	5N4 S
1A74211-505	Y	0414	FCI	404A45A8		A0	6J26	2	1B51211-505	09	5N4 S
1A74211-505	Y	0416	FCI	404A45A9		A0	6J26	2	1B51211-505	09	5N4 S
1A74211-505	Y	0421	FCI	404A45A10		A0	6J26	2	1B51211-505	09	5N4 S
1A74211-505	Y	0434	FCI	404A3A17	25AS0	120	6K16	2	1B39550-511	07	5N4 S
1A74211-505	V	00249	FCI	411A99A10A11	23FS0	100	6J20	2	1B51379-511	06	5N4 S
1A74211-505	V	00250	FCI	411A99A10A12	23FS0	100	6J20	2	1B51379-511	06	5N4 S
1A74216-503	V	0476	FCI	404A45A5	23FS0	100	6J20	1	1B51211-505	09	5N4 S
1A74216-503	V	00434	FCI	411A99A10A6	25AS0	120	6K16	1	1B51379-511	06	5N4 S
1A74216-505	W	00460	FCI	404A3A23	25AS0	120	6K16	1	1B39550-511	07	5N4 S

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1A74216-505	W	00461	FCI	404A3A13	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74218-505	Z	00319	FCI	A49		00P	7E08	2	1B66933	NA	5N4 S
1A74216-505	W	00462	FCI	404A3A21	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74218-505	Z	0460	FCI	404A3A12	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74218-505	Z	0465	FCI	404A3A14	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74218-505	Z	0473	FCI	404A45A11		A0	6J26	1	1B51211-505	09	5N4 S
1A74218-505	Z	0475	FCI	404A2A2	25AS0	230	6J26		1B51354-507	07	5N4 S
1A74218-505	Z	0480	FCI	404A3A20	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74218-505	Z	0481	FCI	404A3A44	25AS0	120	6K16	1	1B39550-511	07	5N4 S
1A74218-505	Z	00462	FCI	411A99A10A10	23FS0	100	6J20	1	1B51379-511	06	5N4 S
1A74765-507	NA	209	FCI	401A11S1	15SA0	25	7B14	2	1B62563	NA	5N4
1A74890-501	M	00105	FCI	404A2A7		REM	7C04	2	1B51354-509	07	5N4 S
1A74890-501	M	00109	FCI	404A45A2		A0	6J26	1	1B51211-505	09	5N4 S
1A74890-501	M	00110	FCI	404A2A10	25AS0	230	6J26		1B51354-507	07	5N4 S
1A74890-501	M	00111	FCI	411A99A10A2	23FS0	100	6J20	1	1B51379-511	06	5N4 S
1A74890-501	M	00114	FCI	404A2A9	25AS0	230	6J26		1B51354-507	07	5N4 S
1A77310-503.1	AA	0131	FCI	411A98A2	23FS0	95	7A09	2	1B55394	NA	5N4 S
1A77310-503.1	AA	0132	FCI	411A99A33	23FS0	100	7A09	2	1B57997	NA	5N4
1A77310-503.1	AA	0132	FCI	411A99A33	23FS0	100	7A09	1	1B57997	NA	5N4 S
1A77310-503.1	AA	0136	FCI	404A52A7	25AS0	216	6L29	2	1B55397	NA	5N4 S
1A86847-509	NA	050	FCI	401A11S1 S2	12C00	REM	7C20	2	1B62563	NA	5N4 S
1A88061-1	NA	284	FCI	404A2A7S1		A0	6E18	2	1A74890-501	00105	5N4
1A88061-1	NA	285	FCI	404A2A7S2		A0	6E18	2	1A74890-501	00105	5N4

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1A88061-1	NC	305	FCI	411A99A10S1		A0	6F22	1	1A74890-501	00111	5N4
1A88061-1	NC	307	FCI	411A99A10S2		A0	6F22	1	1A74890-501	00111	5N4
1A88061-1	NA	308	FCI	404A2A10S1		A0	6F22	2	1A74890-501	00110	5N4
1A88061-1	NA	309	FCI	404A2A10S2		A0	6F22	2	1A74890-501	00110	5N4
1A88061-1	NC	310	FCI	404A45A2S1		A0	6F16	2	1A74890-501	00109	5N4
1A88061-1	NC	318	FCI	404A45A2S2		A0	6F16	2	1A74890-501	00109	5N4
1A88061-1	NA	326	FCI	404A2A9S1			6H09	2	1A74890-501	00114	5N4
1A88061-1	NA	328	FCI	404A2A9S2			6H09	2	1A74890-501	00114	5N4
1A89617-1.3	H	0207	FCI	404A74A2A7		00P	7A30	2	1A74039-517	00017	5N4
1A89617-1.3	H	0212	FCI	404A74A1A6		A0	7A21	1	1A74039-517	046	5N4
1A89617-1.3	H	0213	FCI	404A74A1A7		A0	7A21	1	1A74039-517	046	5N4
1A89617-1.3	H	00140	FCI	404A74A1A5		A0	7A21	1	1A74039-517	046	5N4
1A89617-1.3	H	00185	FCI	404A74A2A5		00P	7A30	2	1A74039-517	00017	5N4
1A89617-1.3	H	00187	FCI	404A74A2A6		00P	7A30	2	1A74039-517	00017	5N4
1B29319-23BCP	AG	00026	FCI				6C23	2	1B29319-519	00026	5N4
1B29319-519	NA	00026	FCI		23TS0	40	7B11	2	1B62563	NA	5N4 S
1B32647-505	R	058	FCI	404A45A3		A0	6J26	1	1B51211-505	09	5N4
1B33084-503	K	011	FCI	411A97A19	23FS0	90	7A09	2	1B55394	NA	5N4 S
1B33084-503	K	012	FCI	411A97A13	23FS0	90	7A09	2	1B55394	NA	5N4 S
1B39550-511	AK	07	FCI	404A3	25AS0	120	6L15	2	1B55397	08	5N4 S
1B39975-X-501	H	0254	FCI	404A2A16	25AS0	230	6J26		1B51354-507	07	5N4
1B39975-X-501	H	0255	FCI	404A2A17	25AS0	230	6J26		1B51354-507	07	5N4
1B39975-501	H	0240	FCI	404A3A37	25AS0	120		1	1B39550-511	07	5N4

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1B39975-501	H	0241	FCI	404A3A5	25AS0	120		1	1B39550-511	07	5N4
1B39975-501	H	0242	FCI	404A3A1	25AS0	120	6K16	1	1B39550-511	07	5N4
1B39975-501	H	0243	FCI	404A3A39	25AS0	120		1	1B39550-511	07	5N4
1B39975-501	H	0245	FCI	404A3A3	25AS0	120		1	1B39550-511	07	5N4
1B39975-501	H	0250	FCI	404A3A43	25AS0	120			1B39550-511	07	5N4
1B40604-1.2	B	052	FCI	411A99A10A35	23FS0	100	6J28	1	1B51379-511	06	5N4
1B40604-1.2	C	067	FCI	404A2A18	25AS0	230	6J26		1B51354-507	07	5N4
1B40604-1.2	E	079	FCI	404A3A42	25AS0	120		1	1B39550-511	07	5N4
1B40604-1.2	E	084	FCI	404A3A7	25AS0	120		1	1B39550-511	07	5N4
1B40604-1.2	E	0111	FCI	A51		00P	7E08	2	1B66933	NA	5N4
1B40604-1.2	E	0112	FCI	A50		00P	7E08	2	1B66933	NA	5N4
1B40824-503	NA	185	FCI	NA	18SA0	70	7B02	2	1B58005	NA	5N4
1B40824-503	NA	198	FCI	NA		00P	7E01	2	1B64424	NA	5N4
1B40824-505	NC	156	FCI	NA		REM	7C09	2	1B51444	NA	5N4
1B40887-501	P	0229	FCI	404A3A46	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0250	FCI	404A2A15	25AS0	230	6J26	1	1B51354-507	07	5N4 S
1B40887-501	P	0282	FCI	411A99A10A4	23FS0	100	6J20	1	1B51379-511	06	5N4 S
1B40887-501	R	0288	FCI	404A45A6		A0	6J26	1	1B51211-505	09	5N4 S
1B40887-501	P	0295	FCI	404A3A2	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0296	FCI	404A3A18	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0297	FCI	404A3A6	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0298	FCI	404A3A10	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0299	FCI	411A99A10A5	23FS0	100	6J20	1	1B51379-511	06	5N4 S

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1B40887-501	P	0300	FCI	404A3A8	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0301	FCI	404A3A16	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B40887-501	P	0302	FCI	404A3A4	25AS0	120	6I29	1	1B39550-511	07	5N4 S
1B42290-503	NC	0020	FCI	A1	23TS0	65	7A25	2	1B58006	NA	5N4
1B44386-507	N	0107	FCI	411A92A6A2			6L13	2	1A59358-525	013	5N4
1B44386-509	N	0109	FCI	411A92A6A3			7A10	2	1A59358-525	013	5N4
1B51211-505	W	09	FCI	404A45	25AS0	200	6L21	2	1B55397	NA	5N4 S
1B51354-507.1	Z	07	FCI	404A2	25AS0	230	6L27	2	1B55397	08	5N4 S
1B51361-1	NC	224	FCI	NA	22TS0	75	7B02	2	1B51444	NA	5N4
1B51361-1	NC	226	FCI	NA	22AS0	40	7A18	2	1B58003	NA	5N4
1B51361-1	NC	247	FCI	NA	22AS0	40	7A18	2	1B58003	NA	5N4
1B51361-1	NC	256	FCI		22TS0	55	7A23	2	1B58003		5N4
1B51361-1	NC	259	FCI	NA	22AS0	40	7A18	2	1B58003	NA	5N4
1B51361-1	NA	280	FCI	NA	19SA0	40	7B08	2	1B58003	NA	5N4
1B51361-501	NA	232	FCI	403A74A3		F0	6L12	2	1B56653-507	00021	5N4
1B51361-501	NC	279	FCI	403A74A3	12C00	REM	7C17	2	1B56653-507	00020	5N4
1B51379-511.2	AJ	06	FCI	411A99A10	23FS0	100	7A09	2	1B57997	NA	5N4 S
1B52623-515	E	015	FCI	403S2		REM	7D11	2	1B58001		5N4
1B52624-511	NC	014	FCI	411S2	20FS0	25	7A13	2	1B58000	NA	5N4
1B52624-513	NC	012	FCI	411S4	20FS0	25	7A13	2	1B58000	NA	5N4
1B52624-515	NC	27	FCI	S4	22TS0	70	7A24	2	1B58001	NA	5N4
1B52624-515	NC	29	FCI	S8	22TS0	70	7A24	2	1B58001	NA	5N4
1B52624-517	NC	010	FCI	S3	22TS0	70	7A20	2	1B58001	NA	5N4

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1B52624-519	NC	22	FCI	S1	22TS0	70	7A20	2	1B58001	NA	5N4
1B53920-503	H	041	FCI		19SA0	30	7B01	2	1A59098	NA	5N4
1B55408-503	D	00019	FCI	NA	23TS0	40	7A17	2	1B62563	NA	5N4 S
1B56653-507		00046	FCI	403A74A3		00P	7E01	2	1B58009	NA	5N4
1B56653-507		00047	FCI	403A73A4		00P	7E01	2	1B58009	NA	5N4
1B57731-1	NC	337	FCI	404A51A4	25AS0	226	7A03	2	1B55397		5N4
1B57731-1	B	349	FCI	404A71A19	25AS0	147	6L20	2	1B55397	NA	5N4
1B57781-503	NA	00029	FCI	A2		00P	7E16	2	1B58006	NA	5N4
1B59010-503	J	120	FCI	403A7	17SA0	1	7E05	2	1B62676-505	NA	5N4
1B59010-503	J	122	FCI	424A7	17SA0	1	7E05	2	1B62676-505	NA	5N4
1B62600-507	M	07	FCI		17SA0	1	7D29	2	1B62676-505	NA	5N4
1B65292-501	D	020	FCI	A17		00P	7E05	2	1B64424	NA	5N4
1B65292-501	D	021	FCI	A15		00P	7E01	2	1B64424	NA	5N4
1B65292-501	NC	039	FCI	1UMA30	22FS0	00P	7A16	2	1B52500	NA	5N4
1B65292-501	NC	085	FCI	1UMA1	22TS0	00P	7A17	2	1B58003	NA	5N4
1B65292-501	NC	105	FCI	1UMA2	22FS0	00P	7A16	2	1B52500	NA	5N4
1B65292-501	NC	111	FCI	1UMA44	22TS0	00P	7A17	2	1B58003	NA	5N4
1B65292-501	NC	112	FCI	1UMA9	22TS0	00P	7A17	2	1B58003	NA	5N4
1B65292-501	NC	113	FCI	1UMA43	22TS0	00P	7A17	2	1B58003	NA	5N4
1B65292-501	NC	118	FCI	1UMA3	22FS0	00P	7A16	2	1B52500	NA	5N4
1B65319-503	B	012	FCI	404A70A1	25AS0	126	7A20	2	1B51291	NA	5N4 S
1B65673-1	A	5	FCI			REM	7C10	2	1B58008	NA	5N4
1B66230-501	NC	1037	FCI	403A73A3	23TS0	50	7A25	2	1B58007		5N4 S

PART NUMBER	CL	SER NO.	MEAS NO.	REF LOCATION	CHART	JOB	DATE	LOC	N-A PART NO.	NA SN	STAGE
1B66988-1	B	03	FCI	404A71A1		00P	7E06	2	1B63798	NA	5N4
1B67193-501-005	ANA	04	FCI		22FS0	140	7E22	2	1A39322	NA	5N4
103826	NA	2094	FCI	NA	15SA0	15	7B09	2	1A66894	NA	5N4
40M32016-1	NA	2B312	FCI	411A97A19		F0	6L08	2	1B33084-503	011	5N4
40M32016-1	NA	2B313	FCI	411A97A13		F0	6L08	2	1B33084-503	012	5N4
40M39515-113	NC	238	FCI	TDI404A75A1	25AS0	211	6L28	2	1B55397	NA	5N4
40M39515-113	NC	239	FCI	TDI A2	25AS0	211	6L28	2	1B55397	NA	5N4
40M39515-113	NC	240	FCI	TDI404A47A2	25AS0	221	6L28	2	1B55397	NA	5N4
40M39515-113	NC	245	FCI	TDI404A47A1	25AS0	221	6L28	2	1B55397	NA	5N4
40M39515-119	E	463	FCI	TDI411A99A12	23FS0	100	7A09	2	1B55709-501	NA	5N4
40M39515-119	E	464	FCI	TDI411A99A20	23FS0	100	7A09	2	1B55709-501	NA	5N4
50M67864-5	NA	159	FCI	TDI411A99A2		F0	6J25	2	1B65319-503	012	5N4
7851823-503	NC	1070	FCI	ACINA	24AS0	30	6L15	2	1B58003	NA	5N4
7851823-503	NC	1086	FCI	ACINA	24AS0	30	6L15	2	1B58003	NA	5N4
7851824-503	NA	1057	FCI	403A74A3		F0	6L12	2	1B56653-507	00021	5N4
7851844-501	NC	67	FCI	NA	24AS0	30	6L15	2	1B58006	NA	5N4
7851861-1	NC	14	FCI	ACINA	24AS0	30	6L15	2	1B58008	NA	5N4

APPENDIX V

RETESTING REQUIREMENTS

APPENDIX V

RETESTING REQUIREMENTS

A detailed listing of all Engineering Orders, Failure and Rejection Reports, and Removals which were worked subsequent to VCL checkout, or remain open from any previous period are tabulated in this Appendix.

Completion of the following tests prior to Acceptance Firing at STC will satisfy all retest requirements of the modifications tabulated in this Appendix:

1B41005	Hydraulic System Setup and Operation
*1B44471	Cryogenic Temperature Sensor Verification
*1B44472	T/M and RS Antenna Subsystem Checkout
1B44473	Level Sensor and Control Unit Calibration
1B55813	Stage Power Setup
1B55815	Power Distribution Subsystem Auto Checkout
*1B55816	DDAS Auto Calibration
1B55817	DDAS Subsystem Auto Checkout
1B55823	PU Subsystem Auto Checkout
*1B55824	Hydraulic Subsystem Auto Checkout
*1B55825	APS Subsystem Auto Checkout
1B62753	Propulsion System Auto Checkout
1B71877	Propulsion System Leak Checks

All of the above tests, except those marked with an asterisk are part of the normally planned STC prefire testing.

Note: The following nonstandard abbreviations do not appear in the Glossary and are applicable to this table only.

STC - Retest at STC	N/A - Not Applicable	REM - Removal
C - Complete	INC - Incomplete	N/R - Not Required
	R/NAA - Rocketdyne	

APPENDIX V

RETESTING REQUIREMENTS

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2879	2049	1B58003 AF	INC			Replace 1B66692-1 actuation control modules with the -501 configuration. Parts are not available. Job will be completed at STC.
		1B58003 009	SEE REMARKS	N/A		Allows the use of 1B65292-501 actuation control modules as interim use material in lieu of 1B66692 modules. IUM parts will be replaced at STC prior to static firing.
		1B52500 Z	INC			Replace 1B65292-501 actuation control modules with 1B66692-1 modules. Parts are not available. Job will be completed at STC.
		1B52500 005	SEE REMARKS	N/A		Allows the use of 1B65292-501 actuation control modules as interim use material in lieu of 1B66692 modules. IUM parts will be replaced at STC prior to static firing.
2883	2019	1A39322 EF	C	1B71877	STC	Replace 1B51753 continuous vent module with 1B67193-501 module. (Remove 1B51753-501-007 regulator and 1B64602-1, 1B64603-1 and 1B64618-1 pipes as IUM parts.)
		1B67193 004	SEE REMARKS	N/R		Allows the use of 1B51753-501-007 regulator as interim use material in lieu of the 1B67193-501 continuous vent module. IUM part replaced by working 1A39322 EF above.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2883 (Cont.)	2019	1B52500 007	SEE REMARKS	N/R		Allows the use of 1B64602-1, 1B64603-1, and 1B64618-1 pipe assemblies as interim use material in lieu of flight parts required to connect the continuous vent module (Ref. 1B67193-004 above). IUM parts replaced by working 1A39322 EF above.
		REM. 1B64606-1 PIPE ASSEMBLY	C	1B71877	STC	To work 1B52500-007.
		REM. 1B64607-1 PIPE ASSEMBLY	C	1B71877	STC	To work 1B52500-007.
		REM. 1B64608-1 PIPE ASSEMBLY	C	1B71877	STC	To work 1B52500-007.
		REM. 1B64609-1 PIPE ASSEMBLY	C	1B71877	STC	To work 1B52500-007.
		1B42497 N	C	1B62753	STC	Connection of wire harness could not be completed because IUM continuous vent module was installed. Connection was made and job completed when the IUM module was replaced with the flight part.
2887	0620	1B32995 003	C	N/R		Rework forward skirt tunnel seal by drilling a hole through 1B34824-507 for a feed-thru connector.
3071	2090	1A39322 EA	C	1B71977	STC	Replace 1A49988-1 directional control valve with -501 configuration.
3082	2027	1A49568 001A	C	1B44471 1B55823 1B55817 1B71877	STC STC STC STC	Remove 1B42292-1 receptacle and inspect the coaxial center contacts.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3171	2051	1B58006 U (#2)	C	1B71877	STC	Replace the 1B57781-501 cold helium dump module with the -503 configuration.
3173	2169	1A39295 023A	C	N/R		Rework the aft skirt and plenum chamber segment to provide access to the new vacuum monitoring system fitting.
3249	2091	1B62563 V	C	1B55824	STC	Install a 1B66241-511 aux. motor driven pump. (Rework from A -509 configuration.)
		REM. 1B31356-505 TRANSDUCER	C	1B55824	STC	To work 1B62563 V.
		REM. 1B32333-1 PIPE	C	1B55824	STC	To work 1B62563 V.
		REM. 1B32332-1 PIPE	C	1B55824	STC	To work 1B62563 V.
		REM. 1B55897-1 PIPE	C	1B55824	STC	To work 1B62563 V.
		REM. 1B32330-1 PIPE	C	1B55824	STC	To work 1B62563 V.
		REM. 1B32329-1 PIPE	C	1B55824	STC	To work 1B62563 V.
		REM. 1B66205-1 PIPE	C	1B55824	STC	To work 1B62563 V.
		REM. 403W3-P2 CONNECTOR	C	1B55824	STC	To work 1B62563 V.
		REM. 404W208-P39 CONNECTOR	C	1B55824	STC	To work 1B62563 V.
		REM. MC266B902 PACKING	C	1B55824	STC	To work 1B62563 V.
		REM. 1B37878-511 TRANSDUCER	C	1B71877	STC	To work 1B62563 V.
3291	2130	1B58003	C	N/R		Verify that 1A49990-501 tank has been tested per ASTM B342-63 and reidentify as -505.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3292	2132 2133	1B57997 J	C	1B55817 1B44472	STC STC	Remove 1B52721-509 R.F. assembly and install -521 configuration.
		REM. PT06 CONNECTORS	C	N/R		To work 1B57997 J.
3293	2096 2048	1B58318 H	C	1B62753	STC	Add one wire in wire harness 411W6 to permit hardwire talkback from the continuous vent system.
		1B44389 U	C	N/R		Add mounting provisions for A54 connector to the sequencer panel assembly.
		REM. PT06 CONNECTORS	C	1B62753	STC	To work 1B44389 U.
		REM. 1B39550-511 PANEL	C	1B55813 1B62753	STC STC	To work 1B44389 U.
		1B39550 AU	C	1B62753	STC	Add one 1B57771-561 connector to the sequencer.
		1B59277 E	C	1B62753	STC	Add one wire in wire harness 404A4W1.
3309	0943	1B51296 M	C	N/R		Modify panel number 18-S5 to provide clearance for DSV-4B-402 access kit.
		1B57776 G	C	N/R		Revise top left corner of panel to agree with 1B51296 M above.
		1B57776 E	C	1B55817	STC	Revise one corner of signal conditioner panel assy.
		REM. TA716WD CLAMPS	C	N/R		To work 1B57776 E.
		REM. PT06 AND DS07-19-2S-9 CONNECTORS	C	1B55817 1B44473	STC STC	To work 1B57776 E. To work 1B57776 E.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
		1B42497 S	C	N/R		Reroute seven wire harnesses in the forward skirt.
3314	2180	1A39321 CJ	C	1B71877	STC	Remove 1B58803-1 pipe assembly.
		1A39321 CH	C	1B71877	STC	Replace 1A49590-513 lox relief valve with the -515 configuration. (Remove 1A49590-513-018 "IUM" part.)
		1A49590 018	SEE REMARKS	N/R		Allows the use of 1A49590-513-018 lox relief valve as interim use material in lieu of the -515 valve. IUM part replaced by working 1A39321 CH above.
3320	2040	1B58329 A	C	1B55815	STC	Add two wires for measurement C211-411 to wire harness 411W205.
3348	2160	1A48431 008	C	1B55823	STC	Rework the LH_2 mass probe connector by cutting off all coaxial contacts and replacing them with new 4703-14-0024 contacts per DPS 54002-10.
		1A48430 011	C	1B55823	STC	Rework the lox mass probe connector by cutting off all coaxial contacts and replacing them with new 4703-14-0024 contacts per DPS 54002-10.
		1B58247 001	C	1B44471 1B44473 1B55823	STC STC STC	Rework all 1B37872-503 connectors on wire harness 408W200 by cutting off all coaxial contacts and replacing them with new 4703-14-0024 contacts per DPS 54002-10.
		1B58968 001	C	1B44471 1B44473 1B55823	STC STC STC	Rework all 1B37872-503 connectors on wire harness 406W1 by cutting off all coaxial contacts and replacing them with new 4703-14-0024 contacts per DPS 54002-10.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3348 (CONT.)	2160	1B58253 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect DS07-19-2S-9 connectors on wire harness 410W201 for recessed pins per DPS 54002-10.
		1B58253 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect 1B37872-513 connectors on wire harness 410W201 for recessed pins per DPS 54002-10.
		1B58324 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect DS07-19-2S-9 connectors on wire harness 404W208 for recessed pins per DPS 54002-10. Ref. FARR A248520.
		1B58324 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect 1B37872-513 connectors on wire harness 404W208 for recessed pins per DPS 54002-10.
		1B58983 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect DS07-19-2S-9 connectors on wire harness 411W11 for recessed pins per DPS 54002-10. Ref. FARR A248520.
		1B58983 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect 1B37872-511 & -513 connectors on wire harness 411W11 for recessed pins per DPS 54002-10.
		FARR A248520	C	N/R		Inspection per 1B58324 and 1B58983 noted above revealed three connectors with recessed pins. Engineering dispositioned parts to be acceptable for use. No corrective action taken.
		1B67152 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect DS07-19-2S-9 connectors on wire harness 404W30 for recessed pins per DPS 54002-10.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3348 (CONT.)	2160	1B67152 NTD	C	1B44471 1B44473 1B55823	STC STC STC	Remove and inspect 1B37872-511 & -513 connectors on wire harness 404W30 for recessed pins per DPS 54002-10. Ref. FARR A257638.
		FARR A257638	C	N/R		Inspection per 1B67152 noted above revealed connector P7 with loose sockets and a bent pin. Faulty connector was replaced.
		REM. 1B37872-513 CONNECTOR	C	1B55823 1B44471 1B44473	STC STC STC	To work FARR A257638.
		1B63247 A	C	1B44471	STC	Reissue of product acceptance test for internal LOX tank harness installation caused by rework per 1A48430-008 SEO.
		1A79603 D	C	1B44471 1B44473	STC STC	Reinstallation of LOX instrumentation probe following rework.
3356	2134	1B57996 K	C	1B55817 1B55816	STC STC	Replace 1B62513-513 & -529 multiplexer assemblies with -543 and -547 configuration respectively.
		REM. PT06 CONNECTORS	C	N/R		To work 1B57996 K.
		REM. 50286 CONNECTORS	C	N/R		To work 1B57996 K.
3372	2175	1A39316 CY	C	N/R		Add 1A39316-187 doubler to provide a hole for a fitting through the thrust structure.
3374	2174	1A49541 M	C	N/R		Install an angle bracket to support the transducer tube on the chilldown return duct.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3374 (CONT.)	2174	1A49546 Y	C	1B71877 1B55817	STC STC	Add 1B28599-1 retaining strap and attaching hardware.
3400	2183	1A59098 CC	C	N/R		Rework the 1A49966-501 fuel recirculation pipe bellows to the -503 configuration.
		REM. 1B28111-1 FAIRING	C	N/R		To work 1A59098 CC.
3401	2184	1A39322 EC	INC			Rework the 1A49320-501 and -507 low pressure fuel feed ducts to the -509 and -511 configurations respectively. Job to be completed at STC.
		REM. 1B68531-4 DOOR ASSY.	C	N/R		To work 1A39322 EC.
		REM. 1B28109-1 FAIRING	C	N/R		To work 1A39322 EC.
3408	2189	FARR A159325	C	N/R		Reliability of spot welds on the 973500 fixed mount sleeve is questionable. Rework per 1A48431-009 SEO.
		1A48431 009	C	N/R		Rework the fuel mass probe lower mount assembly by installing seven cherry rivets. This procedure replaces the spot weld method of attachment.
3425	2193	1B55397 U	C	N/R		Remove 18 each NAS1351 screws from the aft skirt mounting panel and replace with NAS1351-P cadmium plated screws.
3458	2204	1B56653 M	C	1B71877	STC	Remove the 7851824-503 relief valve, serial number 1053, from the repressurization control module assy.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
MISCELLANEOUS (CONT.)		1B67010 A	C	1B55815	STC	Replace CA2182-11 receptacle with 144002-323 connector on aft skirt battery cable.
		REM. 404W11-P1 CONNECTOR	C	N/R		To work 1B67010 A.
		1B67011 A	C	1B55815	STC	For 1B67011-1, replace CA2182-12 receptacle with 144002-363 connector on aft skirt battery cable. For 1B67011-501, replace CA2182-11 receptacle with 144002-323 connector on aft skirt cable.
		REM. 404W9-P2 CONNECTOR	C	1B55815	STC	To work 1B67011 A.
		REM. 404W10-P1 CONNECTOR	C	1B55815	STC	To work 1B67011 A.
		1B67014 A	C	1B55815	STC	For 1B67014-1, replace CA2182-11 receptacle with 144002-323 connector on aft skirt battery cable. For 1B67014-501, replace CA2182-12 receptacle with 144002-363 connector on aft skirt battery cable.
		REM. 404W15-P14 CONNECTOR	C	1B55815	STC	To work 1B67014 A.
		REM. 404W9-P2 CONNECTOR	C	1B55815	STC	To work 1B67014 A.
		1B67010 B	C	N/R		Revise bracket assembly for aft skirt battery cable.
		1B67011 B	C	N/R		Revise bracket assembly for aft skirt battery cable.
		1B42498 AP	C	N/R		Coil and stow excess wire in harness 404W7.
		1A39264 023	C	N/R		Rework battery mounting supports to add spacers to provide flat plane for battery mounting.

WRO	ECP	E.O., FARR OR REMOVAL		MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
MISCELLANEOUS (CONT.)		1A39295	DA	C	N/R		Remove sealant from door and structure on aft skirt.
		1B51292	S	C	N/R		Add two 1B38982-1 spacer nuts to aft attitude control panel to support wiring.
		REM. PT-6 CONNECTORS		C	1B55813 1B62753	STC STC	To work 1B51292 S.
		1B42498	AR	C	N/R		Revise installation of wire harness 404W7 breakout.
		1B42498	AU	C	N/R		Revise installation of wire harness in aft skirt.
		1A66248	012	INC			Return one hydraulic actuator to the vendor (Moog, Inc.) to have the electrical connectors replaced with a different part. Job will be completed at STC.
		1B42498	AS	C	N/R		Revise installation of wire harness 404W231 and miscellaneous brackets in aft skirt.
		1B55397	S	C	N/R		Revise reference designation on aft electrical panel.
		1B42498	AT	C	N/R		Revise installation of wire harness 401W200.
		FARR A248702		C	N/R		Vendor reported the 1A66240-503 engine driven hydraulic pump was suspected to have excessive shaft seal leakage and nonconformance to finish requirements. The 1A86847-509 hydraulic pump thermal isolater assembly (including the

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
MISCELLANEOUS (CONT.)		FARR A248702 (CONT.)				1A66240-503 pump) was removed and replaced with a new unit.
		FARR A248886	C	N/R		Vendor reported suspected nonconformance: incorrect safety wire used in 1A66240-503 engine driven hydraulic pump. 1A86847-509 hydraulic pump-thermal isolater assembly. (Including the 1A66240-503 pump) was removed, inspected, found to be acceptable, and reinstalled on the stage.
		FARR A261101	C	N/R		One 1B37268-503 support was missing on the thrust structure. Two 1B53563-47 clips were riveted to the thrust structure to pick up wire run clamp.
		FARR A261103	C	N/R		The 1B54542-15 clip was mislocated on the aft skirt. Clip was relocated properly and existing holes were plugged.
		FARR A248914	C	N/R		Stringer no. 57 has a dent in the standing leg and a 1/8 inch crack 12 3/4 inches from aft attach angle. A hole was drilled to remove the defect and a NAS-1398-D6 rivet installed per DPS 13056.
		FARR A261104	C	N/R		Engine J-2094 had a sharp dent in tube No. 164 below hat band No. 6. Area was brazed by Rocketdyne per Rocketdyne procedures.
		FARR A261105	N/A			Standoff 1B37428-513 broken on panel 1B58924-1. Wire harness clamp relocated also, one excess hole drilled through 1B52940-1 bracket. Dispositioned as acceptable to Engineering.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
MISCELLANEOUS (CONT.)		FARR A257902	C	N/R		Relay control package 1B57731-1, S/N 337, did not show evidence of production acceptance test being performed. Package was removed, tested satisfactorily per 1B53606 procedure, and reinstalled on the stage.
		REM. 1B57731-1 RELAY CONT. PKG. (ATTACH. HDWE. ONLY)	C	N/R		To work FARR A257902.
		REM. 1B57731-1 RELAY CONT. PKG.	C	1B55825		To work FARR A257902.
		1B55311 D	C	N/R		Revise rivet pattern on -5 angle of CDF clamp assembly.
		1B67270 B	C	1B55825	STC	Rework wiring harness 404A2W1 to show correct reference designation on two connectors.
		1B39254 AC	C	N/R		Provide a hole in aft skirt stringer 55 for a clipping point for 1B65055 tube assembly.
		1B65109 008	INC			Enlarge cutout in 1B65110-529 segment of heat impingement curtain. Job is held for release of 1B65109 A change which will relocate the cutout.
		1B62563 Y	C	N/R		Provides special torque instructions for fasteners in phenolic block.
		1B55479 A	C	N/R		J-2 engine receiving test was held open pending resolution of FARR A233660. FARR was subsequently voided and receiving test paper completed.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
MISCELLANEOUS (CONT.)		1A66894	C	N/R		Installation of J-2 engine was completed but paper was held open pending resolution of FARR A233660. FARR was subsequently voided and installation paper completed.
		1B51354 011	INC			Retesting of the aft 28 volt power distribution assembly per 1B67420-1 is not required. Paper is held open pending resolution of contractual position with NASA.
		REM. 1A86847-509 HYD. PUMP	C	1B41005 1B55824	STC STC	To work FARR A248886.
		REM. 401W200 P-1 CONNECTOR	C	1B55817	STC	To work FARR A248886.
		REM. 404W7 P-4 CONNECTOR	C	1B55815	STC	To work FARR A248886.
		REM. 1B63072-1 FLEX HOSE	C	1B41005 1B55824	STC STC	To work FARR A248886.
		REM. 1B63007-1 FLEX HOSE	C	1B41005 1B55824	STC STC	To work FARR A248886.
		REM. 1B63009-1 FLEX HOSE	C	1B41005 1B55824	STC STC	To work FARR A248886.
		FARR A257907	INC			The 10 amp. fuse in the DC power control circuit of the 1B61117-1 purge unit opened when the fuel prop valve switch was closed. Problem was isolated to a wiring harness that was erroneously connected. Continuity test on wiring harness 411W6P2 to 411A99A10J8 will be performed at STC.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
MISCELLANEOUS (CONT.)		FARR A228592	SEE REMARKS			Three leaks were detected during the propellant systems leak checks. Below listed removals were issued to allow correction of the leaks. Removed items were reinstalled in Tower 8 and retested (as applicable).
		REM. 1A87736-1 DUCT	C	1B65763	C	
		REM. 1A49966-501 DUCT	C	1B65763	C	
		REM. 1B59960-1 DUCT	C	1B65763	C	
		REM. 1B49954-1 VALVE	C	1B65763	C	
		REM. 1A89104-509 FLOWMETER SENSOR	C	1B55817 1B71877	STC	
		REM. 411W205-P19 CONNECTOR	C	1B55817	STC	
089A	X181	1B62679 B	C	N/R		Provide cutout for burner installation.
		1B62894 J	C	N/R		Replace rivets in LH_2 feed line support with blind fasteners.
		1B63463 A	C	N/R		Provide for removal of cap, coupling, & gasket for shipping & sealing.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
089A (CONT.)	X181	1B63800 B	INC			Replace 1B51689-501 transducers with the -503 configuration. Job to be completed at STC.
		1B64423 NEW	C	1B71877	STC	Provide manifold, pipes, clamps, etc. for sphere installation.
		REM. 1A67863-503 TRANSDUCER	C	1B55813 1B62753	STC STC	To work 1B64423 NEW.
		REM. 1A67863-503 TRANSDUCER	C	1B55813 1B62753	STC STC	To work 1B64423 NEW.
		REM. 1B34473-505 TRANSDUCER	C	1B55813 1B62753	STC STC	To work 1B64423 NEW.
		REM. MFC60026-025S FLANGE	C	1B71877	STC	To work 1B64423 NEW.
		1B65418 NEW	C	1B55813 1B62753	STC STC	Rework environmental control system for burner installation.
		1B58005 F	C	1B71877	STC	Rework the pneumatic system installation for use with the burner.
		REM. 1B66924-1 PIPE	C	1B71877	STC	To work 1B58005 F.
		1B58005 F no. 1	C	N/R		Remove 1A97405-1 pipe assy.
		1B58324 K	C	1B55813	STC	Rework wiring harness 404W208 to remove six wires no longer required for measurements C390 and C398.

WRO	ECP	E.O., FARR OR REMOVAL		MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2871	0547	1B67089	B	C	N/R		Reroute two wires in wiring harness 404W203 to provide for redesigned bi-level summing network module.
2879	2049	1B64424	K	INC			Install 1B66692-501 actuation control modules. Parts are not available. Job will be completed at STC.
		1B64424	001	SEE REMARKS	N/A		Allows the use of 1B65292-501 actuation control modules as interim use material in lieu of 1B66692 modules. IUM parts will be replaced at STC prior to static firing.
		1B64424	L	INC			Verify installation per this EO held for completion of 1B64424 K.
2887	0620	1B66647	NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 404W208 and re-identify. (Identical to 1B58324)
		1B66647	A	C	N/R		Change reference designation on wiring harness 404W208 P25 and P48. Delete measurement D87, C390 & C398. Add measurement D236. Rework to add amplifier for measurements C395, C396, & C397.
		1B66647	C	C	N/R		Reterminate wire for measurement D227.
		1B65076	A	C	N/R		Install LH_2 feed line brace.
		1B66644	NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 403W200 and reidentify. (Identical to 1B58309)
		REM. TA716WD-11F CLAMPS		C	N/R		To work 1B66644 NEW.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	1B66644 A	C	N/R		Revise reference designation. Measurement C205 is replaced by C2012.
		1B66938 NEW	C	1B55813 1B62753	STC	Rework wiring harness 404A2W1 and reidentify. (Identical to 1B51044)
		1B66938 A	C	N/R		Revise wiring of four connectors.
		1B66938 B	C	1B55813 1B62753	STC STC	Reroute three wires for I.U. interface accessibility.
		1B66962 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 404W201 and reidentify. (Identical to 1B58259)
		1B66966 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 404A3W1 and reidentify. (Identical to 1B34883)
		1B66966 B	C	1B55813 1B62753	STC STC	Revise one wire number to eliminate duplication.
		1B66967 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 404A4W1 and reidentify. (Identical to 1B59277)
		REM. 1B58189-501 PANEL	C	1B55813 1B62753	STC STC	To work 1B66967 NEW, A, and B.
		REM. PT06CE CONNECTOR	C	1B55813 1B62753	STC STC	To work 1B66967 NEW, A, and B.
		REM. S0286E22 CONNECTOR	C	1B55813 1B62753	STC STC	To work 1B66967 NEW, A, and B.
		REM. PT06CE CONNECTOR	C	1B55813 1B62753	STC STC	To work 1B66967 NEW, A, and B.
		1B66967 C	C	N/R		Revise wire gauge for two wires.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	1B64350 B	C	1B71877 1B62753	STC STC	Added bracket to support ignitor cable.
		1B64350 C	C	N/R		Remove four washers to increase nut engagement.
		1B64340 E	C	N/R		Locates supports and jumpers.
		1B66969 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 411A99A10W1 and reidentify. (Identical to 1B34485-1)
		REM. S0286 E CONNECTOR	C	1B55813 1B62753	STC STC	To work 1B66969 NEW and A.
		1B66970 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 403W2 and reidentify. (Identical to 1B58313)
		FARR A257628	C	N/R		Pin KK would not stay inserted in connector P3 on wire harness 403W2 (1B66970 NEW), P3 connector was removed and replaced.
		1B66970 C	C	1B55813 1B62753	STC STC	Revise wiring of three connectors.
		1B66970 E	C	1B55813 1B62753	STC STC	Revise wire gage of two wires.
		1B66971 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 404W7 and reidentify. (Identical to 1B64948)
		1B66972 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 405W1 and reidentify. (Identical to 1B64951)
		1B66973 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 405W2 and reidentify. (Identical to 1B58314)

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	REM. PT06 CONNECTORS	C	1B55813 1B62753	STC STC	To work 1B66973 NEW.
		1B66973 B	C	1B55813 1B62753	STC STC	Add one grommet to accomodate additional wiring.
		1B66124 A	C	N/R		Rework connector bracket to countersink screw holes.
		1B67003 A	C	1B55813 1B62753	STC STC	Rework aft attitude control panel assembly.
		REM. 1A96207-501 MODULE	C	1B55813 1B55817 1B62753	STC STC STC	To work 1B67003 A.
		REM. 1B57731-1 RELAY CONTROL	C	1B55825	STC	To work 1B67003 A.
		REM. 1A84577-1 MODULE	C	1B55813 1B55817 1B62753	STC STC STC	To work 1B67003 A.
		FARR A228599	C	N/R		Six delron 2086 fasteners were improperly installed · the 1B51292-503 panel. Holes were cleaned and cavities filled with 1P20087 per DPS 22150 while installing fasteners at proper depth.
		1B67045 B	C	1B55813 1B62753	STC STC	Add wire number to one wire in wiring harness 404W33.
		1B67089 NEW	C	1B55813 1B62753	STC STC	Rework wiring harness 404W203 and reidentify. (Identical to 1B58322.)

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	1B67089 A	C	1B55813 1B62753	STC STC	Rework to change three wires. Remove measurement K192 and add K195.
		1B59817 A	C	N/R		Revise rivet pattern and add -9 web for control module support installation.
		1B59817 B	C	N/R		Remove -5 spacer shorten bolt length.
		1B63783 F	C	1B71877 1B62753	STC STC	Removes helium bottle and modifies structure to allow installation of the burner.
		REM. 1A67863-505 TRANSDUCER	C	1B55813 1B62753	STC STC	To work 1B63783 F.
		REM. PT06 CONNECTORS	C	1B55813 1B62753	STC STC	To work 1B63783 F.
		1B64446 J	C	N/R		Rework thrust structure support installation.
		1B65024 D	C	1B71877 1B62753	STC STC	Rework pneumatic supply for incorporation of dual repressurization.
		REM. 1A67863-503 TRANSDUCER	C	1B55813 1B62753	STC STC	To work 1B65024 D.
		1B64174 P	INC			Revise installation of wiring harnesses 404W300 and 403W9. Held for release of 1B64174 P. Job to be completed at STC.
		1B63801 E	INC			Revise cable routing and supports. This job will be accomplished at STC when parts are available per 1B63801 H (see WRO 3431).

WRO	ECP	E.O., FARR OR REMOVAL		MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	1B64448	C	C	N/R		Change bolts for resiliant mount.
		1B64174	E (No.1)	C	1B55813 1B62753 1B55817	STC STC STC	Install 1A68589-509 transducer.
		1B64174	E (No.2)	INC			Install wire harnesses. Held for completion of 1B63801 H (see WRO 3431).
		1B64174	E (No.3)	INC			Megger test and torque connectors on harnesses installed. Held for completion of 1B64174 E (No. 4) below.
		1B64174	E (No.4)	INC			Remove 1B63296-1 wire harness and add 1B63297-1 wire harness. Held for release of 1B64446 P. Job will be completed at STC.
		1B64174	E (No.5)	C	1B55813 1B62753	STC STC	Remove 1A97262-1 wire harness and add 1B67095-1 wire harness.
		1B64174	G	C	N/R		Revise routing and clamping arrangement of harness installations.
		1B66968	C	C	N/R		Revise reference designations of wiring harness 411A9W1.
		1B64399	E	C	1B55817 1B62753	STC STC	Provide for measurements D236 and C2012.
		1B63783	H	C	N/R		Removes 1B27632-1 fitting and associated hardware from structure.
		1B64174	J	C	1B55813 1B62753	STC STC	Revise routing of wire harness 405W2A3.
		1B64446	L	C	N/R		Remove standoff that interferes with piping installation.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	REM. 1B52539-1 PIPE ASSEMBLY	C	1B71877	STC	To work 1B64446 L.
		FARR A228596	C	N/R		Six support assemblies 1B37888-529 instead of 1B37889-529 supports were bonded onto the LOX dome. Dispositioned as acceptable to Engineering for use. Six channels and spacers were added to the supports to complete piping installation.
		FARR A228598	C	N/R		Connector 1B34883-1, wiring harness 404A3W1-P13, had a split in the rubber grommet. Connector was disassembled and grommet was replaced.
		FARR A248892	C	N/R		Pipe assembly 1B62876-1 was too short to mate with fitting. Pipe was redeveloped and identified as 1B62876-1-A248892.
		FARR A261102	C	N/R		Holes in stringer do not line up for installation of 1B37207-99 support bracket. Unused holes were plugged with rivets and a second attach clip was installed.
		1B58324 K	C	1B55813 1B62753	STC STC	Rework wiring harness 404W208 to provide for measurements C395, C396, and C397.
		1B67271 B	C	1B62753	STC	Rework wiring harness 404A2W1 to show correct reference designation on two connectors.
		REM. PT07CE P1 & P2 CONNECTORS	C	1B55815 1B55823	STC STC	
		1B62676 L	C	1B71877 1B62753	STC	Install the burner and associated piping for dual repressurization.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2887 (CONT.)	0620	REM. 1B59010-503 VALVE	C	N/R		To work 1B62676 L.
		1B64424 K	INC			Modify the pneumatic system for incorporation of dual repressurization. Job is complete except for actuation control modules (see WRO 2879).
		REM. 1B62801-1 PIPE ASSY.	C	1B71877	STC	To work 1B64424 K.
		REM. PT06 CONNECTORS	C	1B55813 1B62753	STC STC	To work 1B64424 K.
		REM. 1B66913-1 PIPE ASSY.	C	1B71877	STC	To work 1B64424 K.
		1B63798 M	SEE REMARKS	1B55817 1B71877	STC STC	Install transducers and associated hardware dual repressurization system. Job is complete except for two operations. See WRO 3431, 1B63801 H.
		1B64340 F	C	N/R		Add hole to provide clipping point for retaining strap.
		1B64446 M	C	N/R		Rework support installations.
		1B66933 C	C	1B55813 1B62753	STC STC	Rework control panels.
2989	0681	1B66967 A	C	N/R		Reroute two wires in wiring harness 404AW41 to allow checkout of the redundant depletion sensors.
		1B66968 A	C	1B55813 1B62753	STC STC	Reroute two wires in wiring harness 411A9W1.

WRO	ECP	E.O., FARR OR REMOVAL	MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
2989 (CONT.)	0681	1B66971 A	C	1B55813 1B62753	STC STC	Add one connector and associated wiring to wiring harness 404W7.
		1B66972 A	C	N/R		Add one connector and associated wiring to wiring harness 405W1.
3049	1008	1B66938 D	C	N/R		Reroute two wires in wiring harness 404A2W1 to maintain redundant engine cutoff
		1B67271 NEW	C	N/R		Rework wiring harness 404A2W1. (Identical to 1B66938.)
3066	0581	1B66970 A	C	1B55813 1B62753	STC STC	Revise two wires in wiring harness 403W2 to provide reset for the fuel injection temperature OK bypass.
3173	2169	1B58324 K	C	1B55813 1B62753	STC STC	Rework wiring harness 404W208 to provide for measurement D237.
3231	2092	1B66933 C	C	1B55813 1B62753	STC STC	Replace the 1B57771-509 connector with the -557 configuration.
3241	0677	1B66966 C	C	1B55813 1B62753	STC STC	Revise two wires in wiring harness 404A3W1 to provide redundant relay for 70 pound ullage engine start.
		1B67271 D	C	1B55813 1B62753	STC STC	Reterminate two wires and delete one wire in wiring harness 404A2W1.
		1B66970 B	C	1B55813 1B62753	STC STC	Add two wires to wiring harness 403W2.
		1B66966 F	C	1B55813 1B62753	STC STC	Reterminate one wire and add four wires to wiring harness 404A3W1.

WRO	ECP	E.O., FARR OR REMOVAL		MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3269	2117	1B64424	K	INC			Add 1B67481-1 check valves to the actuation control modules. Parts are not available. Job will be completed at STC.
3293	2048 2096	1B66966	D	C	1B55813 1B62753	STC STC	Revise wiring in harness 404A3W1 to permit hardwire talkback from the continuous vent system.
		1B66967	B	C	1B55813 1B62753	STC STC	Revise wiring harness 404A4W1.
		1B66968	B	C	1B55813 1B62753	STC STC	Revise wiring harness 411A9W1.
		1B66969	A	C	1B55813 1B62753	STC STC	Revise wiring harness 411A99A10W1.
		1B66971	B	C	1B55813 1B62753	STC STC	Add one wire to wiring harness 404W7.
3320	2040	1B66647	B	C	1B55813 1B62753	STC STC	Add measurements C131, C211, and C212 to wiring harness 404W208.
3370	2109	1B63421	B	C	1B55813 1B62753	STC STC	Rework wiring harness 403W10 to provide propellant valve talkback indications.
		1B63298	C	C	1B55813 1B62753	STC STC	Rework eight wires in wiring harness 403W9.
3431	2188	1B66970	D	C	1B55813 1B62753	STC STC	Revise wiring in harness 403W2 due to deletion of the burner back pressure system.
		1B63801	H	INC			Replace 1B59986-501 exciter with the -503 configuration. Replace 1B37878-501 transducers with the -507 configuration. New

WRO	ECP	E.O., FARR OR REMOVAL		MOD. STATUS	RETEST PROCEDURE	RETEST STATUS	REMARKS
3431	2188 (CONTINUED)	1B63801					hardware not available. Job will be accomplished at STC.
		1B62676	K	C	1B71877 1B62753	STC STC	Remove 1B62600-507 burner assembly for rework to the -511 configuration.
		1B64424	K	C	1B71877 1B62753	STC STC	Eliminate the back pressure system for burner operation.

APPENDIX VI

GLOSSARY OF TERMS

GLOSSARY OF TERMS

ABCL	As Built Configuration List. A listing of the part number, change letter, and manufacturing position index number. Compiled by the Reliability Assurance Department from the manufacturing paper applicable to the stage.
ACS	Automatic Checkout System (Complete Complex).
AFQA	Air Force Quality Assurance
AGC	Automatic Gain Control
AM	After Machining
AO	Assembly Outline. Document controlling the assignment of work to assembly areas, and providing a record of conformance. Planned and released by Manufacturing Planning and verified through Reliability Assurance (Quality Control) procedures.
APS	Auxiliary Propulsion System
ASI	Automatic Spark Igniter
BM	Before Machining
CCO	Contract Change Order
COAL	A computer routine for changing data in memory.
Countdown	Tasks carried on during the backward counting (in minutes and seconds) from initiation to conclusion of a propellant loading, or static firing exercise.
Critical Components	Those functional components essential to stage performance.
CLT	Cargo Lift Trailer
DDAS	Digital Data Acquisition System
DPS	Douglas Process Standard
Dye Check	Dye Penetrant Inspection. Visual identification of surface weld defects, such as porosity and cracks, with a colored dye.
EBW	Exploding Bridge Wire System
ECL	Engineering Configuration List. A tabulated listing of the Douglas/vendor part numbers, Douglas/government/industry standard part numbers, specification and source control drawing numbers, processes and material specification numbers,

GLOSSARY OF TERMS (CONTINUED)

ECL (Cont.)	test requirement drawing numbers, bulk material identification numbers, serialized engineering order and drawing change request engineering order numbers, plus the part number and drawing change letters defining the engineering released design intent applicable to this end item.
ECP	Engineering Change Proposal
End Item	A customer-required system, or any principal system or subsystem elements. Also, those articles covered by major subcontracts, delivered direct to a customer, or provided as customer furnished property to a contractor.
EO	Engineering Order. Engineering document which is used to release design intent, for development and manufacture.
FARR	Failure and Rejection Report. A report used to identify or divert nonconforming material. Also used to record dispositions of such material, and the corrective action taken to prevent recurrence.
FACI	First Article Configuration Inspection
Form DD250	A material inspection and receiving report used to transfer an end item from one location or responsible agency to another.
Form DD829-1	Historical record used to document scope change verification.
FTC	Florida Test Center. Douglas Missile and Space Systems Division test center at Cape Kennedy, Florida.
Growler Inspection	A sonic inspection method for detecting internal discontinuities in Saturn stage common bulkheads.
GSE	Ground Support Equipment. Equipment whose function is to transport, protect, handle, service, test, checkout and monitor the complete Saturn S-IVB stage, separate assemblies, or components.
H&CO	Handling and checkout drawing (test procedure)
He	Helium
IIS	Inspection Item Sheet
IU	Instrument Unit
IUM	Interim Use Material

GLOSSARY OF TERMS (CONTINUED)

KSC	Kennedy Space Center, located in Florida
LH_2	Liquid Hydrogen
LOX	Liquid Oxygen
Log Book	A compilation of special records, packaged in book form, pertaining to a given end item.
MRB	Material Review Board. A committee which evaluates and determines the disposition of all rejected material (other than obvious scrap or incompletes) and initiates corrective action to prevent recurrence of the nonconformances leading to the rejections.
NPC 200-2	NASA Quality Publication. The Quality Program Provisions for Space Systems Contractors.
OLSTOL	On Line Saturn Test Oriented Language. A method of manual (i.e. typewriter) input to correct a computer program.
PAM	Pulse Amplitude Modulated radio transmission
PAT	Production Acceptance Test
PCM	Pulse Code Modulated radio transmission
PCL	Planning Configuration List. Tabulated listing prepared by the planning release group containing that information listed on the Engineering Configuration List plus information required by the planning and manufacturing departments.
PDS	Production Data Sheet
Permanent Nonconformance	A condition, signifying material is nonconforming at the time of inspection, and cannot be made to conform exactly.
Permeability	Degree to which one substance will diffuse through or penetrate another.
Porosity	Gas pockets or voids free of solid material occurring in welds.
PDM	Pulse Duration Modulation of radio transmission.
P/N	Part number
PMR	Programmed Mixture Ratio

GLOSSARY OF TERMS (CONTINUED)

ppm	Parts per million
PU	Propellant Utilization system
PUEA	Propellant Utilization Electronic Assembly
psia	Pounds per square inch, absolute. Pressure measurement which includes atmospheric pressure.
psig	Pounds per square inch, gauge. Pressure measurement which does not include atmospheric pressure.
QEC	Quality Engineering Chart. A chart, prepared by Quality Engineering, which provides specific inspection instructions to shop personnel, and a means of recording sequential inspection for each unit fabricated.
RACS	Remote Automatic Calibration System (telemetry checkout).
RF	Radio Frequency
RMR	Reference Mixture Ratio
RPM	Revolutions per minute
RMT	Remaining Material Thickness
RS	Range Safety
RSRS	Range Safety Receiver System
SC	Scope Change. Changes, requirements, or details of all or any part of a program.
sccm	Rate of flow measurement - standard cubic centimeters per minute.
scim	Rate of flow measurement - standard cubic inches per minute.
SCO	Subcarrier Oscillator
SEO	Serial Engineering Order. Engineering orders, generally used to authorize and describe rework in conjunction with a production change. The SEO is also used to issue information or work authorization when no drawing change is involved, i.e., salvages for manufacturing errors, and authorization for variation from Engineering drawing requirements or information.
SIM	Safety Item Monitor
SPCR	Saturn Program Change Request

GLOSSARY OF TERMS (CONTINUED)

SSB	Single Sideband, radio transmission
SSC	Space Systems Center. Douglas Missile and Space System Division Center at Huntington Beach, California.
STC	Sacramento Test Center, located at Sacramento, California
S/N	Serial Number
TACD	Test Area Control Document
TAN	Task Authorization Notice. Douglas work authority.
TCC	Test Control Center.
TCS	Thermo-Conditioning System.
TD	Technical Directive
Time/Cycle Significant Item	A component or end item, the measured life of which is important enough to justify running time, cycle, or attribute data collection.
T/M	Telemetry
TOCC	Test Operator Control Console
TR	Test Request
UHF	Ultra High Frequency
Ullage Pressure	The pressure of the gases in the unfilled portion of the propellant tanks.
Ultrasonic Inspection	An inspection method employing ultrasonic waves to detect discontinuities in internal insulation bonding.
Umbilical	Stage/GSE interface point for stage servicing and monitoring from a ground source.
VCL	Vehicle Checkout Laboratory, located at SSC and STC.
VCO	Voltage Controlled Oscillator
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio. A measure of antenna efficiency.
WRO	Work Release Order. Document providing authority for the accomplishment of work within the Douglas Missile and Space Systems Division.